NUCLEAR SCIENCE ABSTRACTS

Volume 30 Number 5

Abstracts 12202-14740

September 15, 1974

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Volume 30, Number 5, September 15, 1974

NUCLEAR SCIENCE ABSTRACTS

A semimonthly publication of the USAEC Office of Information Services
Published by the USAEC Technical Information Center

Nuclear Science Abstracts provides the only comprehensive abstracting and indexing coverage of the international nuclear science literature. It covers scientific and technical reports of the U. S. Atomic Energy Commission and its contractors, other U. S. Government agencies, other governments, universities, and industrial and research organizations. In addition, books, conference proceedings, individual conference papers, patents, and journal literature on a worldwide basis are abstracted and indexed. Each issue of *Nuclear Science Abstracts* includes four indexes: subject, personal author, corporate author, and report number.

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Numerous organizations, societies, and publishers throughout the world provide *Nuclear Science Abstracts* with advance page-proof copy of their publications.

A list of the journals scanned regularly and the abbreviations used appears in the January 15 issue of *Nuclear Science Abstracts* and is supplemented in the July 15 issue. The January 15 issue also describes the scope and arrangement of the subject matter covered in *Nuclear Science Abstracts*. The subject matter covered is also described in TID-4552, *Subject Scope of Nuclear Science Abstracts*, available free from the USAEC Technical Information Center, P. O. Box 62, Oak Ridge, Tennessee 37830. An outline of the subject categories appears in the Contents of each issue.

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Vols. 21–25, Subjects, Authors, and Corporate Authors (1967–1971), $195.00.

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INDEXES TO NSA

Comprehensive indexes appear in each issue and are cumulated at the end of each volume. The report number indexes will be cumulated on both a volume and two-volume basis. Multi-volume cumulations have been issued as indicated above.

All documents abstracted are indexed by subjects and personal authors. Report literature is indexed also by corporate author and report number. Each of these indexes in every issue is preceded by an introduction explaining in detail the organization of the index and the principles by which it is compiled. The reader is referred to these explanations for information not found in the brief summaries below.

Personal Authors

Each author's name is indexed in the form appearing on the document abstracted, with the exception that given names are reduced to initials:

```
SMITH, H., Planetary nebulae:  two
    types, 29:13374
SMITH, H.R. Jr., Principles of
    electron beam technology, 29:13155
SMITH, J., See HOEGERMAN, S.F.,
    29:13035
  See HOEGERMAN, S.F., 29:13037
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Subjects

The subject index consisting of entries naming specific materials, objects, and processes is arranged alphabetically. Document titles, informative phrases, or both specific to these entries are arranged alphabetically under the entries.

Examples:

```
REACTOR LICENSING/SPAIN
  Harmonization of the licensing conditions including
    environmental protection for the siting of nuclear
    power plants, 29:14745
REACTOR MATERIALS/STRESS ANALYSIS
  Problems on nuclear reactor structure at elevated
    temperature, 29:14654
REACTOR PROTECTION SYSTEMS
  HTGR gas turbine power plant control and safety studies.
    Quarterly progress report for the period July 1, 1973--
    September 30, 1973, 29:14846 (GULF-GA-A-12799)
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Corporates

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14452 (WASH-1278) CTR ENGINEERING SYSTEMS STUDY REVIEW MEETING, GERMANTOWN, MARYLAND, SEPTEMBER 19 AND 20, 1973. Gough, W. C. **(USAEC Division of Controlled Thermonuclear Research, Washington, D. C.).** 1973. 258p. (CONF-730971-). Dep. NTIS $7.60.

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  WASHINGTON, D.C.
  CTR engineering systems study review meeting, Germantown,
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  73-2            29-13070  See N-73-27584

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  7757            29-14785
  7758            29-14786
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AVAILABILITY OF PUBLICATIONS ABSTRACTED

Public availability of all U. S. Atomic Energy Commission reports is indicated in the report number indexes. The availability of other reports, when known, is also indicated. The availability of some unnumbered reports is given in the abstract.

Dissertations from *Dissertation Abstracts International, Part B* that are included in *Nuclear Science Abstracts* are available from University Microfilms, Inc., 315 N. First Street, Ann Arbor, Michigan 48103.

Information on the availability of the published literature and unpublished conference papers abstracted in *Nuclear Science Abstracts* can be obtained from the USAEC Technical Information Center, P. O. Box 62, Oak Ridge, Tennessee 37830.

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Use of funds for printing this publication approved by the Director of the Office of Management and Budget, June 19, 1972.

Volume 30, Number 5 September 15, 1974

NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical and Separations Chemistry

Refer also to abstract 14536.

Activation and Nuclear Reaction Procedures

12202 (AEC-CONF-73-479-3) PLANS FOR ACTIVATION ANALYSIS WITH CHARGED PARTICLES. Petri, H.; Erdtmann, G. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Zentralinstitut fuer Analytische Chemie). 1973. 5p. (In German). INIS.

From fourth seminar on activation analysis of the Bundesanstalt fuer Materialpruefung; Berlin, West Germany (11 Oct 1973).

The experimental devices for the activation analysis utilizing a compact cyclotron are described and the resulting possibilities are discussed. The advantages of this method are based on the high sensitivity in the determination of some light elements (C, N, O, S). In cooperation with the Institute for Solid State Research, the determination of these elements in suprapure materials and crystals is planned. Besides these special studies, the method will also be used for other analytical tasks. (INIS)

12203 (DP-MS-74-23) ^{252}Cf ACTIVATION ANALYSIS AT THE SAVANNAH RIVER LABORATORY. MacMurdo, K. W.; Bowman, W. W. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. (USA). Savannah River Lab.). 1974. Contract AT(07-2)-1. (CONF-740608-12). Dep. NTIS $6.50.

From annual meeting of the American Nuclear Society; Philadelphia, Pennsylvania, USA (23 Jun 1974).

Automated multielement analyses are being obtained with a neutron activation facility at the Savannah River Laboratory using a ^{252}Cf source. The facility consists of a 15-mg ^{252}Cf source shielded with 10 ft of light water moderator. The fully automated pneumatic rabbit system consists of a control unit, a sample loader, a counting position, two irradiation positions, and an unloader connected by a sample diverter unit. Sample transfers are automatically controlled with preset irradiation, decay, and counting times. Single or dual irradiation and counting sequences are selectable for multiple samples and each sample can be recycled allowing unattended operation of the facility. Data are automatically recorded on magnetic tape at the end of each counting sequence. (LK)

12204 (INIS-mf-1212, pp B36-52) MEASUREMENT OF ATMOSPHERIC BROMINE CONTENT IN BEERSHEBA USING THE ACTIVATION ANALYSIS METHOD. Shani, G.; Hadari, Z.; Cohen, D. (Negev Univ., Beersheba, Israel). 1973.

From fourth scientific conference of the Israel Ecological Society; Tel Aviv, Israel (8 Apr 1973).

Activation analysis is a very sensitive method for detection of trace elements. The sample is irradiated with neutrons, radioactive isotopes are formed and their activity is measured. Because of its sensitivity, the method was selected for air pollution investigation. Among air pollutants in Beersheba there is bromine in a noticeable amount. Air samples were collected for a few months with a Stapler type TF1A-2 air sampler which was placed on the roof of a building at the University of the Negev. Each sample was taken for 24 hours. Other samples were taken during periods of 2 hours sampling time around the clock. The samples were irradiated with neutron flux and their activity was measured. Several types of Whatman filters were used. Results indicate that bromine concentration in the air is $\sim 5 \times 10^{-9}$ mole/l, but when the wind blows from the East continuously, the bromine concentration rises up to 3×10^{-8} mole/l. When the wind blows from the West the concentration decreases to less than 5×10^{-11} mole/l. On certain days or during certain hours, a large amount of bromine is released into the atmosphere and then the bromine concentration rises considerably regardless of the wind direction. Activation analysis does not give any information about the molecule which contains the bromine. This was done with mass spectrometry and it was found that the bromine is in the form of ethyl bromide C_2H_5Br. (INIS)

12205 (NP-20043) ANALYSIS AND CHARACTERIZATION OF TRACE ELEMENTS, IN PARTICULAR BROMINE, SELENIUM, AND ARSENIC IN MARINE ORGANISMS. Lunde, G. (Sentralinstitutt for Industriell Forskning, Oslo (Norway)). 1974. 150p. Dep. NTIS (US Sales Only) $10.75.

Thesis.

The analysis of trace elements in marine organisms has attracted increased interest in recent years. The prefractionation of biological samples into the oil and water-soluble phases prior to determination by neutron activation analysis, atomic absorption spectrophotometry, and x-ray fluorescence is described. Model studies involving growth experiments with algae and feeding experiments with fish to study arsenic absorption and metabolism are also described. The results are then presented for the analyses of heavy metals, halogens, phosphorus and sulphur, selenium and arsenic, in various fish. Reprints of 18 papers follow, on which the discussion in the first part is based. (JIW)

12206 WHOLE-ROCK URANIUM ANALYSIS BY FISSION TRACK ACTIVATION. Weiss, J.R.; Haines, E.L. (Division of Geological and Planetary Sciences and Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California 91103). Rev. Sci. Instrum. 45: No. 4, 606-607 (Apr 1974).

We report a whole-rock uranium method in which the polished sample and track detector are separated in a vacuum chamber. Irradiation with thermal neutrons induces uranium fission in the sample, and the detector records the integrated fission track density. Detection efficiency and geometric factors are calculated and compared with calibration experiments. (auth)

12207 DETERMINATION OF TRACE ELEMENTS IN DUST PARTICLES IN THE AIR USING NEUTRON ACTIVATION. Vogg, H.; Haertel, R. (Kernforschungszentrum, Karlsruhe, Ger.). (1973). vp. (In German).

From meeting of the Gesellschaft Deutscher Chemiker on trace analysis; Erlangen, Germany (2 Apr 1973).

For the determination of the elements Se, V, Br, Mn, Cu, As, Zn, Fe, Co in aerial dust samples, in a concentration range 1 to 1000×10^{-9} ng/m^3 air, an instrumental activation analysis with semiconductor spectrometry and on-line evaluation of gamma spectra has been used. Particular emphasis is placed upon the sampling (rate and completeness of deposition of air pollutes) as well as upon the choice of filter material which is suitable for a reactor irradiation. The results of some test series are given. Furthermore, it is shown that activation analysis of aerial dusts which allows the determination of some 20 to 30 elements in the nanogram/m^3 air range is able to supplement other analytical methods in a meaningful manner and, as far as costs are concerned, can even compete with them. (GE)

12208 DETERMINATION OF TRACE ELEMENTS IN DIFFERENT NATURAL WATER SAMPLES BY MEANS OF NEUTRON

ACTIVATION ANALYSIS. Schneider, J. (Kernforschungszentrum, Karlsruhe, Ger.); Geisler, R. (1973). vp. (In German).

From meeting of the Gesellschaft Deutscher Chemiker on trace analysis; Erlangen, Germany (2 Apr 1973).

In order to develop a routine analysis of drinking water, the activation-analytical determination of As, Cd, Cu, Hg, Sb, and Zn has been performed. The water samples were freeze-dried before irradiation. Irradiation facilities available consisted of a 14-MeV neutron generator, a ^{252}Cf source, and a nuclear reactor. However, sufficient sensitivity for the relevant concentration range could only be reached with thermal neutrons. The post-irradiation treatment of the sample has been as far as possible done purely instrumentally with respect to cost. Only for Cu has a separate irradiation followed by a chemical separation procedure been chosen. The results obtained are compared to the WHO regulations for drinking water. Finally, an evaluation of the analysis costs has been made. (GE)

12209 NEUTRON ACTIVATION DETERMINATION OF THE CONTENT OF OXYGEN AND FLUORINE IN SAMPLES OF ZIRCONIUM AND TANTALUM. Melent'ev, V. I.; Ovechkin, V. V.; Rudenko, V. S. Sov. J. At. Energy (Engl. Transl.); 34: No. 1, 45-46(Jan 1973).

Translated from At. Energ. (USSR); 34: No. 1, 35-36(Jan 1973). This is a summary of paper No. 641/6961 with full copy held at TIC.

A neutron activation method for the separate determination of the content of oxygen and fluorine present in test samples of zirconium and tantalum is described. The samples were alternately irradiated with 14-MeV neutrons and neutrons from a $^{238}Pu-Be$ isotope source, then the γ-radiation of ^{16}N isotope was recorded. (LK)

12210 LIMITATIONS AND INTERFERENCES IN ACTIVATION ANALYSIS. Part II. Physical Limitations. Travesi, A. (Junta de Energia Nucleare, Madrid). Energ. Nucl. (Madrid); 17: No. 83, 205-215(1973). (In Spanish).

Among the physical limitations cited are the change in the neutron flux during its passage through the sample, limitations of spectrometry, and displacement of the gain and threshold. Methods used to calculate the errors produced and means of avoiding them are also discussed. (tr-auth)

12211 DETERMINATION OF URANIUM CONTENT IN SAMPLES BY NEUTRON ACTIVATION ANALYSIS. Fishelson, Z.; Lavi, N. (Soreq Nuclear Research Centre, Yavne, Israel). Radiochem. Radioanal. Lett.; 17: No. 4, 251-255(15 Jun 1974).

In determining the uranium content of a uranium-bearing sample by neutron activation analysis, the $^{235}U/^{238}U$ ratio affects the results due to the higher cross section of ^{235}U. A formula, based on cadmium ratios, is developed taking the ^{235}U abundance into consideration. The method seems to be also suitable for determining the ^{235}U content of a uranium sample of known mass. (auth)

12212 DETERMINATION OF SELENIUM IN SULFUR BY 3-MeV NEUTRON ACTIVATION ANALYSIS. Zikovsky, L.; Boisvert, J. (Ecole Polytechnique, Montreal). Radiochem. Radioanal. Lett.; 17: No. 4, 281-290(15 Jun 1974).

An instrumental method for determination of Se in S, based on the nuclear reaction $^{77}Se(n,n'\gamma)^{77m}Se$, is described. A small 150-kV accelerator was used to produce 3-MeV neutrons. The detection limit for Se detection at a neutron flux of $6 \times 10^8 n \cdot cm^{-2} \cdot s^{-1}$ was equal to 0.1 g or 1%. Scandium and germanium are elements which may interfere in the determination. The total time of the determination was 5 minutes. (auth)

12213 AKTIVIERUNGSANALYSE. Nr. 6. (Activation Analysis. No. 6). Sansoni, B. Bibliographien Zur Kernforschung und Kerntechnik, Sektion 14. Leopoldshafen, Ger.; Zentralstelle fuer Atomkernenergie-Dokumentation (1973). 282p.

The present bibliography continues the series of AED-bibliographies on activation analysis and contains 775 titles mainly published in 1966 and 1967, arranged according to reports, conference papers, journal articles, books and dissertations. An author index as well as a subject index which is subdivided according to elements, matrix material, and marginal subjects completes the compilation. (GE)

12214 DETERMINATION OF RUBIDIUM, CAESIUM, BARIUM, AND EIGHT RARE EARTH ELEMENTS IN ULTRAMAFIC ROCKS BY NEUTRON-ACTIVATION ANALYSIS. Brunfelt, A. O.; Roelandts, I.; Steinnes, E. (Univ. of Oslo). Analyst; 99: No. 1178, 277-284(May 1974).

From third symposium on recent developments in neutron activation analysis; Cambridge, Eng. (2 Jul 1973).

A method for the simultaneous determination of rubidium, cesium, barium, and eight rare-earth elements in rocks by neutron-activation analysis is described. The method is suitable for use with samples with particularly low abundances of the elements concerned. After fusion with alkali and determination of rubidium and cesium in the supernatant liquid, the hydroxide fraction is carried through an anion-exchange step in chloride media and extracted with tri-n-butyl phosphate in order to remove interfering nuclides. Subsequently, barium, strontium, and the rare-earths are separated into three groups by mixed-solvent anion exchange. The method is shown to be suitable for application to ultramafic rocks. Results for rubidium, cesium, lutetium, ytterbium, terbium, europium, samarium, neodymium, cerium, and lanthanum in dunite DTS-1 are presented. Granite (G-2) was also analyzed in order to assess the accuracy of the method. (auth)

12215 ACTIVATION ANALYSIS WITH ENERGETIC PROJECTILES: ACCURACY IN CALCULATING THE LIMIT OF DETECTION. Jaeger, U.; Muerzel, H. (Kernforschungszentrum, Karlsruhe, Ger.). (1973). vp. (In German).

From meeting of the Gesellschaft Deutscher Chemiker on trace analysis; Erlangen, Germany (2 Apr 1973).

The studies refer to (i,xn) reactions (i = α, p, n). With the help of excitation functions which have been experimentally determined as well as those which have been evaluated from a systematic, the detection limit can be accurately determined to a factor of two in nearly all cases, which is sufficient. (GE)

12216 DETERMINATION OF OXYGEN IN SILICON BY ALPHA AND HELIUM-3 ACTIVATION ANALYSIS. Vandecasteele, C.; Adams, F.; Hoste, J. (State Univ., Ghent). Anal. Chim. Acta; 71: 67-77(1974).

A nondestructive analytical method for oxygen in silicon by both helium-3 and α-particle activation analysis was applied to different samples, containing 0.05-10 ppM of oxygen. The accuracy and precision of the method were studied. For concentrations above 1 ppM, the average coefficient of variation is about 6% for α-activation and 13% for helium-3 activation. For concentrations of about 60 ppB, the corresponding figure is about 20%. The results of both methods, which agree within 8%, are compared to infrared analysis. The determination limit of the method is 4 ppB for helium-3 activation and 22 ppB for α-activation. (auth)

12217 DETERMINATION OF SILICON AND OXYGEN IN COAL AND COAL ASH BY 14-MeV NEUTRON ACTIVATION. Block, C.; Dams, R. (State Univ., Ghent). Anal. Chim. Acta; 71: 53-65(1974).

Oxygen and silicon were simultaneously determined in 40 coal samples and 20 coal ash samples, by means of a 15-s 14-MeV neutron irradiation, followed by 15-s and 2-min measurements of the induced ^{16}N and ^{28}Al activities after decay periods of 5 and 75 s, respectively. The standards consisted of silica mixed with spectrally pure graphite. Possible interferences were checked. Only aluminium and phosphorus interfere although slightly, and corrections are possible. The instrumental error (1.8-2.2%) and the inhomogeneity of the coal samples (1.5-2.5%) contribute to the overall reproducibility (2.5-3.5%). Silicon can be a measure of the ash content of coal. (auth)

12218 DETERMINATION OF MERCURY IN AIR BY NEUTRON ACTIVATION ANALYSIS. Van der Sloot, H. A.; Das, H. A. (Stichting Reactor Centrum Nederland, Petten). Anal. Chim. Acta; 70: 439-442(1973).

An important part of pollution studies is the determination of mercury in air. The method of analysis should meet three requirements: (a) the air should be freed from airborne particles; (b) both organically bound mercury and inorganic mercury compounds should be measured; and (c) the sensitivity should be at least 1 ng m^{-3} so that unpolluted air can be analyzed. It was considered that concentration on previously purified activated charcoal followed by neutron activation analysis would produce a very sensitive method. In the procedure described, the mercury is separated from the radioactive matrix by evaporation, followed by absorption on a second carbon absorbent. Concentrations down to 0.5 ng Hg m^{-3} can be determined in this way. (LK)

12219 MERCURY LEVELS IN HUMAN BRAIN, SKELETAL MUSCLE AND BODY FLUIDS. Massaro, E. J. (State Univ. of New York, Buffalo); Yaffe, S. J.; Thomas, C. C. Jr. Life Sci.; 14: No. 10, 1939-1946(16 May 1974).

Neutron activation analysis was employed to quantitate the levels of mercury (Hg) in human tissue and body fluids. Statistical analysis revealed: a. No significant differences ($P > .05$) in Hg levels among the members of each of the following groupings: (i) adult (15-91 years) and sub-adult (neonate through 14 years) frontal and cerebellar cortex, medulla, pons, midbrain, and adult thalamus. (ii) sub-adult thalamus, adult and sub-adult callosal white matter

and angular and supramarginal gyri. (iii) the RBCs, plasma, and urine obtained from apparently healthy volunteers. Also, there was no correlation among the Hg levels of the RBCs, plasma, and urine of any single individual. b. A significantly higher ($P < .001$) Hg level in the tissues listed in a.i above compared to the tissues/body fluids of a.ii and a.iii. c. A significantly higher ($P < .001$) Hg level in the tissues listed in a.ii compared to the tissues/body fluids of a.iii. d. A significantly higher Hg level in the adult gastrocnemius muscle and corpus striatum compared to the tissue/body fluids listed in a.ii ($P < .01$) and a.iii ($P < .001$); but a significantly lower Hg level ($P < .01$) in muscle and striatum compared to the tissues listed in a.i. e. A significant positive effect of age on thalamic Hg levels (adult > sub-adult: $P < .001$); but, in general, no influence of age, weight, height, sex, race, national origin, occupation, religion, cause of death and tissue handling parameters on Hg levels. (auth)

Chemical and Spectral Procedures

Refer also to abstracts 12424, 12833, and 12882.

12220 ANALYTICAL APPLICATIONS OF X-RAY EXCITED OPTICAL LUMINESCENCE. Direct Determination of Rare Earth Nuclear Poisons in Zirconia. D'Silva, A. P.; Fassel, V. A. (Ames Lab., IA). Anal. Chem.; 46: No. 8, 996-999(Jul 1974).

An x-ray excited optical luminescence technique for the direct quantitative determination of fractional ppM levels of rare earth "neutron poisons" in ZrO_2 and Zircaloys is described. A blend of ZrO_2, K_2CO_3, $Sr(NO_3)_2$, and WO_3 is heated to 1050°C for 2 hours to yield a quaternary oxide phosphor host with a composition of $K_2O \cdot 2SrO \cdot 2ZrO_2 \cdot 3WO_3$. The irradiation of this phosphor by x-rays causes the emission of optical line luminescence of the rare earth impurities. When the phosphor sample is irradiated at 150°C, the intense host band luminescence is quenched yielding improved signal to noise ratios for Sm, Dy, Eu, Pr, and Tb, which is the internal reference element. The Gd luminescence, which is quenched at 150°C, is observed at ambient temperatures. The detection limits under these conditions are: 0.05 ppM for Gd, Sm, Pr; 0.1 for Eu; and 0.02 ppM for Dy. (auth)

12221 APPLICATION LIMITS OF THE ADDITIVE METHOD DURING LUMINESCENCE DETERMINATION OF SAMARIUM, EUROPIUM, TERBIUM, AND DYSPROSIUM BY MEANS OF ORGANIC REAGENTS. Poluektov, N. S.; Kononenko, L. I. (Inst. of General and Inorganic Chemistry, Odessa). Zh. Anal. Khim.; 29: No. 4, 695-697(Apr 1974). (In Russian).

Diagrams were obtained of concentration quenching of Sm, Eu, Tb, and Dy for suggested earlier luminescence methods of their determination by means of organic reagents. It is shown that the concentration quenching obeys the Stern-Folmer equation. The concentration quenching constants and from them limit regions of the element contents have been calculated at which the additive method can be used. (auth)

12222 SPECTROPHOTOMETRIC STUDY OF COMPLEX FORMATION OF NEPTUNIUM WITH ARSENAZO M. Novikov, Yu. P.; Margorina, M. N.; Myasoedov, B. F.; Mikhailov, V. A. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim.; 29: No. 4, 698-704(Apr 1974). (In Russian).

The compositions of the complexes of Np(IV) with arsenazo M were determined by means of spectrophotometric data handling; the 1:1 complex is formed in 0.5 N HCl at a neptunium excess, the 1:2 complex is formed in 0.5 N HCl at an arsenazo M excess and in 7 N HCl within a wide range of the neptunium:arsenazo ratio. Two maxima are observed in the visible region of the absorption spectra of the complexes: 612 and 662 nm for the 1:1 complex, and 622 and 664 nm for the 1:2 complex. The second complex is used for spectrophotometric determination of neptunium, $\epsilon_{664} = (1.07 \pm 0.05) \times 10^5$. The formation constant logarithms of the second complex is about 9.9 ± 0.5 for the reaction between $NpCl_4$ and arsenazo M in strongly acid solutions. (auth)

12223 SPECTROPHOTOMETRIC DETERMINATION OF NEPTUNIUM WITH ARSENAZO M. Novikov, Yu. P.; Margorina, M. N.; Myasoedov, B. F.; Usolkin, A. N.; Mikhailov, V. A. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim.; 29: No. 4, 705-709(Apr 1974). (In Russian).

Greatest differences in the color intensity of complexes formed by Np(IV) and some other cations with arsenazo M are in 1.5 to 3 N HCl. 20-Fold excess of uranium does not interfere with the determination of neptunium in 1.5 N HCl at the arsenazo concentration of 4×10^{-5} M. The selectivity of the neptunium determination has been estimated in the presence of 15 various salts in 3 N HCl. The determination sensitivity is 0.1 μg. A determination takes 30 min. (auth)

12224 FLUORESCENT COMPLEXES OF ZIRCONIUM AND HAFNIUM WITH QUERCETINSULPHONIC ACID. Pilipenko, A. T.; Kubibaev, T. U.; Volkova, A. I. (Inst. of General and Inorganic Chemistry, Kiev). Zh. Anal. Khim.; 29: No. 4, 710-715(Apr 1974). (In Russian).

The state of quercetinsulfonic acid (QSA) was studied in strongly acid solution and its protonization constant was calculated ($pK_2 = 2.91 \pm 0.04$). Optimal conditions for the formation, spectrophotometric and fluorescence characteristics of hafnium and zirconium complexes with QSA were determined. The quantum luminescence yield (Q), molar absorptivity at the exciting light wavelength, and product $\epsilon_2 Q$ for the complexes of QSA with hafnium and zirconium were calculated. It was established that hafnium forms with QSA a more intensive fluorescent complex. The fluorescence determination sensitivity is 0.1 μg Hf and 0.2 μg Zr in 5 ml of the ultimate solution. (auth)

12225 COMPLEX FORMATION OF NIOBIUM(V) WITH GALLIC ACID AND ANILINE. Extraction-Photometric Determination of Niobium. Ali-Zade, T. D.; Gamid-Zade, G. A.; Akmedova, G. A. (Azerbaydzhan Inst. of Petroleum and Chemistry, Baku). Zh. Anal. Khim.; 29: No. 4, 735-739(Apr 1974). (In Russian).

A three-component complex of niobium is formed in the niobium (V)-gallic acid-analine system at pH 4 to 5. The complex is quantitatively extracted into a mixture of amyl alcohol with dichloroethane (2:1). The complex composition corresponds to the molar ratio of niobium(V):gallic acid:aniline = 1:1:1. The extract molar absorptivity is 7×10^3. An extraction-photometric procedure was developed for determining 5 to 100 μg Nb in 10 ml. The procedure may be used for the analysis of steel. (auth)

12226 ZINC DETERMINATION IN SEA WATER BY THE SUBSTOICHIOMETRIC ISOTOPE DILUTION METHOD. Petrov, Yu. M. (Polar Scientific-Research Inst. of Sea Fish Industry and Oceanology, Murmansk, USSR). Zh. Anal. Khim.; 29: No. 4, 686-690 (Apr 1974). (In Russian).

The sorption of microamounts of zinc dissoluted in seawater on flask walls was investigated and data on extraction of zinc dithizonate were obtained, 10 to 20% of Zn was found to be absorbed on the flask walls during a 2 min contact with seawater at pH 8.0 to 8.3. This should be considered in various procedures with seawater samples. The substoichiometric dilution method proposed permits determination of zinc in seawater with the accuracy ±3%. (auth)

12227 I. MASS SPECTRAL ANALYSIS OF ZIRCONIUM AND HAFNIUM β-DIKETONATES. II. Application of a Nearest-Neighbor Technique to the Correlation of Gas Chromatographic Liquid Phases. Leary, J. J. Chapel Hill, NC; University of North Carolina (1973). 134p. University Microfilms Order No. 74-5939.

Thesis (Ph. D.).

Chapter I is primarily devoted to microanalyses involving zirconium and hafnium while Chapter II describes the application of a pattern recognition technique to a problem in applied gas chromatography. Chapter I is divided into three sections describing the steps in the application of volatile chelates and mass spectrometry to the analysis of zirconium and hafnium in geological and lunar samples. The initial section describes a general method for the synthesis of zirconium and hafnium β-diketonates from geological samples. The second and third sections describe applications of the mass spectrometry of volatile β-diketonates to the measurement of zirconium-hafnium ratios and to the analysis of zirconium, respectively. The first appendix contains the data acquisition program for the PDP-8 computer used throughout this work. The second chapter treats the problem of reducing the number of gas chromatographic liquid phases to a standard set. In this work a nearest neighbor technique is used to measure the similarity of liquid phases. Temperature considerations are briefly mentioned as are Rohrschneider's Constants. (Diss. Abstr. Int., B)

12228 DETERMINATION OF NIOBIUM AND TANTALUM IN ALUMINOSILICATE MINERALS BY EMISSION SPECTROGRAPHY. Jimenez Seco, J. L.; Gomez Coedo, A. (Ciudad Univ., Madrid). Rev. Met. (Madrid); 9: No. 3, 200-205(1973). (In Spanish).

Computed pellets of 30-mm diameter are formed from 1 part of sample or prepared blank [$SiO_2 - Al_2O_3 - Fe_2O_3$ (40:9:1)] and 4 parts of graphite, and used with graphite counter-electrodes with measurements at 3194.98 and 2868.52 Å for Nb and 2603.57 and 3311.16 Å for Ta, respectively. The method is suitable for concentrations of Nb_2O_5 and $Ta_2O_5 > 0.05\%$ each in the mineral; the precision is ±0.01%. (Anal. Abstr.)

12229 INDIRECT IODIMETRIC DETERMINATION OF NEODYMIUM AND CERIUM(IV) PRESENT TOGETHER. Guseinova, Z. A.; Mamedov, I. A.; Nabiev, M. N.; Anikhanova, N. V. Uch. Zap., Azerb. Inst. Nefti Khim., Ser. 9; No. 4, 79-81(1972). (In Russian).

The method involves precipitation of both Nd and Ce as arsenates and determination of their sum by iodimetric titration of As(V) in a solution of the precipitate in acid. Cerium is determined similarly in another portion of the test solution in which conditions are so adjusted that only Ce is precipitated. (Referativnyi Zh.)

12230 MASS SPECTROMETRIC INVESTIGATION OF TRICYCLOPENTADIENYL COMPOUNDS OF THE RARE EARTH ELEMENTS. Devyatykh, G. G.; Gaivoronskii, P. E.; Larin, N. V.; Borisov, G. K.; Krasnova, S. G.; Zyuzina, L. F. (Inst. of Chemistry, Moscow). Zh. Neorg. Khim.; 19: No. 4, 912-917(Apr 1974). (In Russian).

The mass spectra of tricyclopentadienyl compounds of Y, Ce, Sm, Gd, Tb, Dy, Ho, Er, Tm, Yb, and Lu were studied. The lines of the $C_5H_5M^+$ ion have the maximum intensity in the mass spectra of the Sm and Y compounds, but the $(C_5H_5)_2M^+$ ions give the maximum intensity in the other rare earths. Differences in the mass spectra were explained by the different degrees of ionicity of the metal–cyclopentadienyl bonds. The fragmentation of the molecular ions results in the subsequent splitting of the cyclopentadienyl group, the C_5H_5 group, and the molecules of ethylene and acetylene. The potentials for the appearance of the basic ions were measured and the dissociation energies of the neutral complexes, molecular ions, and the splinter ions were calculated. The dissociation energies of the compounds is decreased with increase of the atomic number of the complexer. The possibility of using tricyclopentadienyl compounds for the isotopic analysis of rare earths was shown. (tr-auth)

12231 DIRECT THERMOMETRIC DETERMINATION OF THORIUM AND LANTHANUM IN GLASSES. Doering, K. (Saale-Glas GmbH, Jena, Ger.). Talanta; 21: No. 4, 312-314(Apr 1974). (In German).

A rapid method is described for the determination of thorium and lanthanum in non-silicate glasses. It is suitable for routine use in a works laboratory. The samples are dissolved in nitric acid. The thorium content is calculated from the measured heat of precipitation of thorium iodate, and the lanthanum content by difference from the heat of precipitation of both thorium and lanthanum oxalates together. The apparatus is calibrated by using standard solutions of the two metal ions. The standard deviations for the middle of the range (around 250 mg of the oxides) were 3.1 mg for ThO_2 and 1.7 mg for La_2O_3. An analysis takes about 1.5 hr. (auth)

12232 DETERMINATION OF URANIUM IN NATURAL WATERS AFTER ANION-EXCHANGE SEPARATION. Korkisch, J.; Goedl, L. (Univ., Vienna). Anal. Chim. Acta; 71: 113-121(1974).

A method is described for the determination of uranium by fluorimetry and spectrophotometry in samples of natural non-saline waters. After acidification with hydrochloric acid, the water sample is filtered and, following the addition of ascorbic acid and potassium thiocyanate, passed through a column of the strongly basic anion-exchange resin Dowex 1-X8 (thiocyanate form). On this exchanger uranium is adsorbed as an anionic thiocyanate complex. After removal of iron and other coadsorbed elements by washing first with a mixture consisting of 50 vol. % tetrahydrofuran, 40 vol. % methyl glycol and 10 vol. % 6 M hydrochloric acid, and then with pure aqueous 6 M hydrochloric acid, the uranium is eluted with 1 M hydrochloric acid. In the eluate, uranium is determined fluorimetrically or by means of the spectrophotometric arsenazo III method. The procedure was used for the routine determination of uranium in water samples collected in Austria. (auth)

12233 CATALYTIC-KINETIC DETERMINATION OF CATALASE, COPPER, MOLYBDENUM, AND IODIDE WITH A BIAMPEROSTAT. Pantel, S.; Weisz, H. (Univ., Freiburg i. B.). Anal. Chim. Acta; 70: 391-400(1973). (In German).

Biamperometrically observable reactions may be evaluated by the "potentiostat" method with the application of a current-to-voltage transducer. The catalase-catalyzed autodecomposition of hydrogen peroxide, the copper-catalyzed oxidation of iodide with peroxydisulfate, the molybdenum(VI)-catalyzed oxidation of iodide with hydrogen peroxide, and the iodide-catalyzed oxidation of arsenic(III) with cerium(IV) are used to illustrate this concept. The catalysts, catalase, copper(II), molybdenum(VI) and iodide, as well as azide as an inhibitor for catalase, can be determined in the ppB–ppM range. (auth)

12234 DETERMINATION OF NIOBIUM, TITANIUM, AND ZIRCONIUM BY HIGH-FREQUENCY PLASMA TORCH EMISSION SPECTROMETRY AND ITS APPLICATION TO STEEL. Nakashima, R.; Saeki, S.; Shibata, S. (Government Industrial Research Inst., Nagoya, Japan). Anal. Chim. Acta; 70: 265-274(1973).

The basic conditions for the determination of niobium, titanium, and zirconium with an argon plasma and a Hitachi UHF Plasma Spectrascan operated at 2450 MHz and 450 W maximum output, were established. The niobium 405.89-nm, titanium 365.35-nm and zirconium 339.19-nm lines gave detection limits of 0.5, 0.1, and 2.0 ppM, respectively, when pure solutions were used. Effects of gas flow rates, high-frequency output and concentration of acids were examined. In applications to steel, titanium was determined without prior chemical separation from iron at the 499.95-nm line, whereas niobium and zirconium could not be determined in the presence of large amounts of iron. When a cupferron precipitation method followed by extraction of iron with methyl isobutyl ketone was applied, satisfactory results were obtained. (auth)

12235 SIMPLE MICROTITRIMETRIC METHOD FOR ALKALINE EARTH METALS. Fano, V.; Licci, F.; Zanotti, L. (CNR, Parma, Italy). Anal. Chim. Acta; 71: 218-221(1974).

A very sensitive titration, which is applicable to the alkaline earth elements either separately or in the presence of calcium, is described. The proposed analytical procedure can be applied to hexagonal ferrite samples and to a large variety of other substances. As little as 2 μmole l^{-1} of magnesium, calcium, strontium and barium can be titrated with an error less than 5-6%. The determination of calcium in the presence of other alkaline earths may be achieved by a very simple procedure. Up to a ratio of alkaline earth to calcium of 2:1, the simultaneous determination is satisfactory. (LK)

12236 FLUOROMETRIC DETERMINATION OF ZIRCONIUM WITH 3-HYDROXYCHROMONE. Ito, T.; Murata, A. (Shizuoka Univ., Japan). Jap. Anal.; 23: No. 3, 274-280(Mar 1974). (In Japanese).

Zirconium reacts with 3-hydroxychromone in dilute hydrochloric acid solution to form a soluble complex, which exhibits a strong absorption in the ultraviolet. In the presence of a large excess of sulfate ion the absorbance of the complex decreases, while a strong fluorescence is observed in the range of pH 1 ~ 2.5. The excitation and emission spectra of the fluorescence have maxima at 358 nm and 417 nm, respectively. The fluorescence intensity changes markedly with concentrations of sulfate ion, 3-hydroxychromone, and methanol. When 3-hydroxychromone is increased at a constant methanol concentration, the sulfate ion concentration required to obtain the maximum fluorescence intensity increases and the range of the sulfate ion concentration in which the complex may show the maximum and constant fluorescence intensity becomes broad, but the maximum fluorescence intensity is kept nearly constant. On the other hand, as methanol is increased at a constant 3-hydroxychromone concentration, the sulfate ion concentration required to obtain the maximum fluorescence intensity decreases and the range of the sulfate ion concentration in which the complex may show the maximum and constant fluorescence intensity becomes narrow, but the maximum fluorescence intensity increases. An analytical procedure is as follows: To a zirconium solution are added 5.0 ml of 2×10^{-2} M methanol solution of 3-hydroxychromone, additional 2.5 ml of methanol, 2M sulfuric acid in order to give final concentration of 0.2M sulfate ion, and an adequate amount of 1M sodium hydroxide solution to maintain pH 1.5 ~ 2.0; the mixture is diluted to 25 ml with water. After about thirty minutes, its fluorescence intensity is measured with an excitation wavelength of 366 nm, using a secondary filter passing above ca. 390 nm. The calibration curve is linear up to 8 μg of zirconium when an aqueous solution of 0.5 μg/ml sodium fluorescein is used as the reference standard. The complex is stable for at least three hours. The effect of diverse ions was also examined. The composition of the complex was examined by the continuous variation method. In the absence of sulfate ion, the molar ratio of zirconium to reagent was 1:2. However, in the presence of sulfate ion, the molar ratio of zirconium to reagent and that of zirconium to sulfate ion were both 1:1. It is likely that one of the two 3-hydroxychromone molecules is replaced by one sulfate ion to form a 1:1:1 complex, which is fluorescent. (auth)

12237 DETERMINATION OF TELLURIUM(IV) IN ACID MEDIA BY POLAROGRAPHY WITH PULSED ALTERNATING CURRENT AND BY LINEAR SWEEP VOLTAMETRY. Volaire, M.; Vittori, O.; Porthault, M. (Univ., Lyon). Anal. Chim. Acta; 71: 185-191(1974). (In French).

Tellurium can be determined polarographically in the range 10^{-5} to 10^{-6} M by means of the $Te^0_{ads} \rightarrow Te^{2-}$ reduction in 1 M perchloric acid as supporting electrolyte. Pulse polarography, a.c. polarography and linear sweep cyclic voltammetry can be used to determine tellurium in the ppB range. Copper(II), arsenic(III), and selenium(IV) interfere, but the interferences can be overcome by a standard addition method. (auth)

Radiometric and Radiochemical Procedures

Refer also to abstracts 12726, 12745, 12776, 12777, 12782, 12785, and 12829–12832.

12238 (AD-771923) INFLUENCE OF RADIOISOTOPE AND LIQUID SCINTILLATION COUNTING SOLUTION ON RADIOISOTOPE COUNTING STABILITY. Morrissey, R. L.; Coleman, R. L. (Army Medical Research and Nutrition Lab., Denver, Colo. (USA)). Sep 1973. 18p. (USAMRNL-336). NTIS $2.75.

The counting stability of ^{14}C, ^{3}H, ^{35}S, ^{45}Ca, and ^{32}P was evaluated in 7 liquid scintillation counting solutions. (GRA)

12239 (LA-UR-74-845) DETERMINATION OF ^{17}O AND ^{18}O ISOTOPIC ABUNDANCES IN ^{238}Pu MATERIALS BY GAMMA SPECTROMETRY. Bubernak, J.; Matlack, G. M. (Los Alamos Scientific Lab., N. Mex. (USA)). [nd]. 30p. (CONF-740626-1). Dep. NTIS $4.50.

From third annual Latin American meeting on radiochemistry; Buenos Aires, Argentina (17 Jun 1974).

A procedure was developed for the nondestructive determination of ^{17}O and ^{18}O isotopic abundances in $^{238}PuO_2$ materials that are used as heat sources. Close control of these isotopes is important because they increase the neutron emission rate caused by (α,n) reactions. The intensities of the gamma rays accompanying these reactions are measured by a Ge(Li) detector and related to the abundance of each isotope. The determination has a detection limit approximating the lowest abundances encountered in PuO_2 samples—5 μg/g of ^{17}O and 10 μg/g of ^{18}O. The accuracy and relative standard deviation for the determination is estimated to be about 25% near the detection limit, and less than 10% for abundances above 100 μg/g. (auth)

12240 (NIM-1592) DETERMINATION OF LINE INTENSITIES IN THE PRESENCE OF INTERFERING SPECTRA IN DISPERSIVE X-RAY-FLUORESCENCE SPECTROMETRY. Project Report No. 2. Austen, C. E. (National Inst. for Metallurgy, Johannesburg (South Africa)). 25 Jan 1974. Dep. NTIS (US Sales Only) $4.25.

Two techniques are described for the determination of the net intensity of an x-ray peak when the background under the peak cannot be accurately evaluated owing to the presence of adjacent spectra. For the first technique the intensity distribution of an x-ray peak that is free from interference is represented by a series of straight-line equations. Two background intensities free from interference, and the gross peak intensities of the analytical line and of the interfering spectra are substituted into simultaneous equations, which are then solved. The second technique involves the measurement of the gross peak intensity of the analytical line and the intensities of two points, one on each sloping side of the analytical peak. These intensity data are then substituted into a simple equation. These two techniques have been successfully applied to the quantitative determination of tantalum and niobium in ores on a routine basis. (auth)

12241 X-RAY RADIOMETRIC ANALYSIS OF GEOCHEMICAL SAMPLES FOR RARE ELEMENTS BY USING A Ge(Li)-DETECTOR. Zaitsev, E. I.; Margolin, E. M.; Polytsya, O. P.; Pan'kin, V. V.; Shchekin, K. I. (Inst. of Mineralogy, Geochemistry, and Crystallochemistry of Rare Elements, Moscow). Zh. Anal. Khim.; 29: No. 4, 668-673(Apr 1974). (In Russian).

Use of semiconductor detectors of x-ray radiation with high resolution makes it possible to increase significantly the sensitivity and selectivity of x-ray radiometric analysis. This permits the quantitative determination of Sr, Zr, Nb, Sn, Cs, La, Ce, and some other rare elements in rocks. The analysis of geological samples by means of semi-conductor detectors is highly accurate, not less than the chemical analysis. It makes it possible to determine simultaneously several elements and ensures high productivity (up to 70 to 100 determinations during a shift). (auth)

12242 ASSAY OF CYCLIC AMP BY AN ISOTOPE DILUTION TEST WITH BINDING PROTEIN. Wunderwald, P.; Jurz, G.; Michal, G. (Boehringer Mannheim GmbH, Tutzing, Ger.). Anal. Biochem.; 59: No. 2, 468-481(Jun 1974).

The radioisotope dilution test for cyclic AMP with binding protein from beef muscle can be described mathematically with the assumption that one molecule of binding protein binds one molecule of cyclic AMP. Formulas for the dose response under saturation and nonsaturation conditions are given. Quasilinear plots are calculated from them even under nonsaturation conditions. Good agreement exists between calculated and measured curves. (auth)

12243 DETERMINATION OF TRACE CONCENTRATIONS OF LEAD IN NATURAL WATERS BY ISOTOPE DILUTION MASS SPECTROMETRY. Hirai, Y. (California Inst. of Tech., Pasadena). Jap. Anal.; 23: No. 2, 158-162(Feb 1974). (In Japanese).

Trace lead concentrations in natural stream waters and snow were determined by isotope dilution mass spectrometry. Owing to the extremely low concentrations of lead, cleaning of sampling containers and analytical laboratory wares were carried out with special care. Sampling bottles of conventional polyethylene were cleaned by 2 solutions of cold concentrated nitric acid and two solutions of 1% nitric acid. Chemical wares of FEP teflon and quartz were cleaned by 3-day exposures to two solutions of hot concentrated nitric acid and a 3-day exposure to 1% nitric acid. After the sampling in the field, samples were kept frozen until time of analysis. A known amount of ^{208}Pb spike was added to about 200 ml of acidified sample solution and cooked one day at 55°C in order to assure the isotopic equilibration of spike and sample lead. Lead was then extracted with 44 ml of dithizone-chloroform solution (3.8 mg dithizone/250 ml chloroform) at pH 7.5 ~ 8.5. Lead was backextracted into an aqueous layer of 10 ml of 0.1 N nitric acid. The lead extraction by 5 ml of dithizone solution was repeated in the presence of 1 ml of 25% ammonium citrate and 2 ml of 1% potassium cyanide at pH 7.5 ~ 8.5. After the back-extraction with 1 N nitric acid solution, the sample was mounted on a rhenium filament with silica gel and phosphoric acid. The isotopic ratios were measured in a solid source mass spectrometer (12-in. radius, single focussing, thermal emission source, equipped with electron multiplier) at the California Institute of Technology. The lead concentrations were 0.02 μg/kg in stream water and 3 μg/kg in snow. The error is considered to be within 3%. The lead contamination from reagents was 0.85×10^{-9} g Pb per one extraction. No lead contamination was detected from the sampling bottle. (auth)

12244 SAMPLE PREPARATION USING SOLUBILIZERS FOR LIQUID SCINTILLATION COUNTING. Maebayashi, A.; Kasida, Y. (National Inst. of Radiological Sciences, Chiba, Japan). Radioisotopes (Tokyo); 23: No. 2, 88-96(Feb 1974). (In Japanese).

For liquid scintillation counting, the digestion techniques of biological materials by commercially available solubilizers, which belong to quarternary ammonium hydroxide, such as Hyamine X10, NCS, Soluene 100 and Digestin were studied. Six kinds of liquid scintillators: PPO + POPOP or butyl PBD in toluene, Davidson's DAM 611, Butler's cocktail, INSTA GEL and Triton X100 in toluene were examined against the solubilizers without biological sample for the coloring and the chemiluminescence and after the experiment, three liquid scintillators, butyl PBD in toluene and both ether systems, were omitted from the next tests for the sake of their strong coloring. Comparing with the solubility of biological material; wet and dry muscular tissue of chicken, liver, kidney, spleen, plasma and blood of rat, the velocity of solubilization vs. the amount of sample was measured. The maximum dissolved weight of sample to 1 ml of each solubilizer is 200 mg in wet case and 100 mg in dry case, respectively. The chemiluminescence due to the mutual action between the scintillator and the solubilized biological sample in strong amine base was observed and its phenomenon decayed by neutralization with extremely small quantities of glacial acetic acid for toluene scintillator or 0.5 N hydrochloric acid for emulsion scintillator. The decoloring treatment for blood and spleen samples by 30% hydrogen peroxide was also described. It is concluded that the solubilizers dissolved in toluene (Soluene and NCS) are superior to those in methanol (Hyamine and Digestin), on the viewpoint of their digestion abilities and tritium counting efficiencies. (auth)

12245 FLUORESCENT EXCITATION ANALYSIS: SIMPLIFIED METHOD FOR IODINE DETERMINATION [IN BIOLOGICAL MATERIAL] IN VITRO. Moss, A. A.; Kaufman, L.; Nelson, J. A. (Univ. of California, San Francisco). Invest. Radiol.; 7: No. 4, 335-338(1972).

The fluorescent excitation spectrum of iodine exposed to ^{241}Am radiation, measured by a multi-channel pulse-height analyzer, exhibits 2 emission peaks (Kα and Kβ) and another peak due to Compton scattering. The concentration of iodine (from x-ray contrast media) in bile, serum, and urine is estimated by relating the photon count in the Kα peak (corrected for background) to that in a narrow region of the Compton peak. A rectilinear relationship is obtained for 0.2 to 40 mg of iodine per ml, the error being ±2%. (Anal. Abstr.)

12246 SEPARATION OF CARRIER-FREE ^{48}Sc TRACER AND ITS DETERMINATION BY ISOTOPIC DILUTION. Purkayastha, B. C.; Das, N. (Saha Inst. of Nuclear Physics, Calcutta). Talanta; 21: No. 4, 310-312(Apr 1974).

An easy method for speedy and quantitative separation of carrier-free scandium tracer formed by the $^{48}Ti_{22}(n,p)^{48}Sc_{21}$ nuclear reaction has been developed. Separation of ^{48}Sc(1.83 days) from the target titanium metal was carried out by coprecipitating the tracer with calcium fluoride precipitated at pH ~ 4 from the

solution of irradiated titanium in hydrofluoric acid. The freshly formed fluoride precipitate was dissolved in conc. hydrochloric acid, and the tracer extracted with tributyl phosphate and then stripped into aqueous medium. The carrier-free tracer was estimated by isotopic dilution, with calcium fluoride as non-isotopic diluent. (auth)

12247 GAMMA-RAY ABSORPTION AND CHEMICAL COMPOSITION OF NEOVOLCANIC ROCKS. Vankova, V.; Kropacek, V. (Geophysical Inst., Prague). Stud. Geophys. Geod.; 18: No. 2, 173-185(1974).

Gamma absorption coefficients $\mu_{c,str}$ for a set of 49 neovolcanic rocks from the Bohemian Massif were measured; their values varied in the range from 0.2092 cm^{-1} to 0.2464 cm^{-1} with an average of 0.2313 cm^{-1}. The dependence of $\mu_{c,str}$ on the density ρ could be expressed by the relation $\mu = 0.0656\ \rho + 0.0348$. The absorption coefficient was correlated with the content of several oxides determined by chemical analysis. In accordance with the results in [1], the values of the absorption coefficient were found to increase with the increasing content of oxides bound to dark minerals (FeO, Fe_2O_3, MgO, CaO), and to decrease with the increasing content of oxides bound to light minerals (Si_2O, Al_2O_3). (auth)

12248 METHODS OF DETERMINING ISOTOPES OF INDUCED ACTIVITY. VII. Determination of ^{182}Ta. Rovinskii, F. Ya.; Iokhel'son, S. B.; Yushkan, E. I.; Sycheva, M. D. Sov. Radiochem. (Engl. Transl.); 15: No. 4, 631-633(1973).

Translated from Radiokhimiya; 15: No. 4, 627-629(1973).

A method was developed for isolating ^{182}Ta from earth samples containing a complex mixture of fission products and products of activation reactions. This method makes it possible to carry out a determination of Zr radioisotopes in parallel. Gamma-spectrometric analysis methods were used to measure the activities of ^{182}Ta, ^{95}Zr, and ^{97}Zr. (auth)

12249 METHODS OF DETERMINING ISOTOPES OF INDUCED ACTIVITY. VIII. Determining of Tungsten Radioisotopes. Rovinskii, F. Ya.; Iokhel'son, S. B.; Yushkan, E. I.; Sycheva, M. D. Sov. Radiochem. (Engl. Transl.); 15: No. 4, 634-636(1973).

Translated from Radiokhimiya; 15: No. 4, 639-631(1973).

A method was developed for isolating radioisotopes of tungsten from samples of earth containing fission and activation products. The radiochemical method was based on the analytical properties of tungsten, which make it possible to isolate it as a precipitate of tungstic acid by action of a mixture of hydrochloric and nitric acids on boiling. The activity of ^{181}W in preparations containing ^{181}W, ^{185}W, and ^{187}W was determined from the spectrum of the characteristic K-radiation, the activity of ^{185}W from the total beta-radiation, and the activity of ^{187}W from the spectrum of the gamma-radiation. (auth)

12250 RADIOCHEMICAL DETERMINATION OF THE RADIOISOTOPES ^{89}Sr AND ^{90}Sr IN SAMPLES FROM THE ENVIRONMENT. Zhilkina, M. I.; Vasil'eva, N. V.; Gedeonov, L. I. Sov. Radiochem. (Engl. Transl.); 15: No. 4, 585-589(1973).

Translated from Radiokhimiya; 15: No. 4, 584-590(1973).

The different variants of the radiochemical determination of strontium isotopes in samples from the environment were classified systematically. The advantage of using each one of them was demonstrated in relation to the age of the nuclide mixture analyzed, the composition of the samples, and the measuring equipment on which the activity of the strontium preparations isolated is measured. In the radiochemical determination of ^{89}Sr and ^{90}Sr in samples from the environment it is advantageous to use the separation of strontium and calcium by means of sodium (potassium) rhodizonate if the ratio Ca/Sr in them is ≤ 5. (auth)

12251 EFFECT OF SORPTION OF RADIOACTIVE ISOTOPES ON RADIOMETRIC PROPERTIES OF POLYSTYRENE SCINTILLATION GRANULES. Ekkerman, V. M.; Seredenko, T. N.; Solomonov, V. M. Sov. Radiochem. (Engl. Transl.); 15: No. 4, 599-603(1973).

Translated from Radiokhimiya; 15: No. 4, 601-604(1973).

An investigation of the effect of sorption of radioactive isotopes on the efficiency of their recording by scintillation plastic granules showed that this effect may be neglected when the cut off of the β-spectrum is higher than 250 keV. A method is given for increasing the sensitivity by using the sorption of radioactive isotopes on the surface of plastic scintillating granules. Plastic scintillation granules may be used for highly efficient recording of α-activities in liquid samples. (auth)

12252 EXTRUDED-EXPANDED POLYSTYRENE. A Smear Material for use in Liquid Scintillation Counting. Slobodien, M. J.; Granlund, R. W. (Pennsylvania State Univ., University Park). Health Phys.; 27: No. 1, 128-129(Jul 1974).

A method has been sought which can be used for liquid scintillation counting of smears and filters used in the detection of low energy β contamination. Such a material must have solubility, low quenching, strength, and low cost. Rag paper, glass fiber discs and squares of $^1/_{16}$ in thick polystyrene foam cut from sheets have been compared. It was found that the extruded-expanded polystyrene dissolves in toluene or xylene based scintillation cocktails, counting efficiency was found to be 35–40%, phosphorescence was minimal and the cost of the material is small. (UK)

Separation Procedures

12253 APPLICATION OF THE CELLULOSE PRESSURE COLUMN FOR THE CHROMATOGRAPHIC SEPARATION OF RADIONUCLIDES. Meier, H.; Zimmerhackl, E.; Unger, E.; Zeitler, G. (Staatliches Forschungsinstitut fuer Geochemie, Bamberg, Ger.). (1973). vp. (In German).

From meeting of the Gesellschaft Deutscher Chemiker on trace analysis; Erlangen, Germany (2 Apr 1973).

By means of practical examples, separation of metal ions and radioisotopes, it is shown that the cellulose pressure column is a useful tool for separating ions rapidly and simply. The relationship between RF-values and medium break-through volume, which has been observed in paper chromatography, can be used to predict separations. Uranium, ^{238}Pu as well as ^{241}Am separations result in very pure fractions which are extremely well suited for alpha spectrometry, due to their small volume. (GE)

12254 SOLVENT EXTRACTION OF A MIXED COMPLEX OF NIOBIUM(V) WITH THIOCYANATE AND 1,10-PHENANTHROLINE. Lobanov, F. I.; Zatonskaya, V. M.; Gibalo, I. M. (Moscow State Univ.). Zh. Anal. Khim.; 29: No. 4, 826-829(Apr 1974). (In Russian).

Conditions were studied for the formation and extraction of an ion associate Nb–SCN^-–Phen. The component ratio in the extracted compound has been found to be $[HPhen^+][NbO(OH)(DCN)_3^- \cdot H_2O \cdot TBP]$. The molar absorptivity is $(4.0 \pm 0.1) \cdot 10^4$ at 400 nm. The distribution ratio for niobium in the 2 M H_2SO_4–2% TBP system in benzene is $\lg D_b = 0.94 \pm 0.005$. The association constant was calculated to be $\lg K_a = 2.65 \pm 0.04$. The effect of metal ions on the extraction-photometric determination of niobium as the mixed complex is considered. (auth)

12255 SIMULATION PROCEDURE FOR DETERMINING THE DISTRIBUTION CURVES IN RADIOMETRIC SEPARATION. Halik, L. (Uranove Doly, Dolni Rozinka, Czech.). Rudy (Prague); 21: No. 5, 135-139(May 1973). (In Czech).

A method is described for determining the distribution curves and other technological parameters exerting essential effects on the results, such as the distribution of the useful component in the ore-bearing rock being separated, the character and magnitude of the background distribution, and the character of the distribution of volumes of pieces within a given grain size. The character of mutual effects (method of feeding over the detector) is also considered. The solution consists in a simulation of the technological process of radiometric separation. The method saves time and costs needed for technological tests. (INIS)

12256 CALCULATION OF OPTIMAL CONDITIONS FOR SUBSTOICHIOMETRIC SEPARATION OF ELEMENT TRACES IN THE PRESENCE OF TWO CHELATE-FORMING REAGENTS. Bilimovich, G. N.; Atrashkevich, V. V.; Alimarin, I. P. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim.; 29: No. 4, 647-658(Apr 1974). (In Russian).

Theoretical possibilities and application limits were estimated for solvent extraction as a method of separation of excess (oversubstoichiometric) amounts of the element to be determined for any systems complexone-metal-extraction reagent. Criteria of the extraction reagent selection were estimated for separation of oversubstoichiometric amounts of the element to be determined in the presence of a complexone. The equations obtained for the calculation of the optimal conditions of substoichiometric element separation were tested on the system of ethylenediaminetetraacetic acid, diethylenetriaminepentaacetic acid–yttrium–thenoyltrifluoroacetone. (auth)

12257 GAS CHROMATOGRAPHY OF METAL CHELATES WITH CARRIER GAS CONTAINING LIGAND VAPOR THORIUM(IV) TRIFLUOROACETYLACETONATE. Fujinaga, T.; Kuwamoto, T.; Murai, S. (Kyoto Univ.). Anal. Chim. Acta; 71: 141-150(1974).

When the conventional gas chromatographic method with helium as carrier gas is used, thorium(IV) trifluoroacetylacetonate shows an anomalous peak and the chelate is not eluted quantitatively. But, by using trifluoroacetylacetone vapor as a carrier-gas additive, the anomalous peak can be improved. The technique of using a carrier gas containing ligand vapor was studied fundamentally,

and was found to be extremely useful in obtaining more reliable chromatographic peaks than those obtained in the absence of ligand vapor. The proposed method furnishes similar quantitative results in the determinations of uranium(IV) and iron(III), as their trifluoroacetylacetonates, and aluminium(III), chromium(III), iron (III) and thorium(IV) as their acetylacetonates. (auth)

12258 SEPARATION OF LITHIUM FROM SODIUM, BERYLLIUM, AND OTHER ELEMENTS BY CATION-EXCHANGE CHROMATOGRAPHY IN NITRIC ACID–METHANOL. Strelow, F. W. E.; Weinert, C. H. S. W.; Van der Walt, T. N. (National Chemical Research Lab., Pretoria). Anal. Chim. Acta; 71: 123-132(1974).

Lithium can be separated from sodium, beryllium, and many other elements by eluting lithium with 1 M nitric acid in 80% methanol from a column of AG50W-X8 sulfonated polystyrene cation-exchange resin. The separation factor is not quite as large as that in 1 M hydrochloric acid in 80% methanol, but many elements, such as Zn, Cd, In, Pb(II), Bi(III), and Fe(III), which form chloride complexes in 1 M HCl–80% methanol are retained quantitatively together with Na, Be, Mg, Ca, Mn(II), Al, Ti(IV), U(VI), and many other elements, when 1 M HNO_3–80% methanol is used for elution of lithium. A method for the accurate determination of traces of lithium in rock samples is described, and some results obtained are presented together with relevant distribution coefficients, elution curves and results for the analysis of synthetic mixtures. (auth)

12259 PARTITION STUDIES IN HEPTANOL/WATER/THORIUM NITRATE AND HEXANOL/WATER/THORIUM NITRATE SYSTEMS. Apelblat, A. (Israel Atomic Energy Commission, Beersheba). J. Chem. Soc., Faraday Trans., I; 70: No. 5, 769-776(1974).

Simultaneous extraction of thorium nitrate and water by heptanol and hexanol is described. Using the Gibbs-Duhem relationship, the activities of alcohols in the ternary systems are calculated for the range 0-2.5 mol dm^{-3} of aqueous $Th(NO_3)_4$. The solubility of water in the alcohols, as a function of water activity, is also determined. (auth)

12260 EXTRACTION OF THIOCYANATE COMPLEXES OF NIOBIUM WITH TRIBUTYL PHOSPHATE. Sych, A. M.; Alekseev, A. F.; Stradomskaya, E. N. (Kiev State Univ.). Zh. Neorg. Khim.; 19: No. 4, 1046-1050(Apr 1974). (In Russian).

The extraction of Nb in the form of thiocyanate complexes by TBP was studied by distribution method and IR spectroscopy. It was established that the compound $[H{\cdot}mH_2O{\cdot}TBP][NbO(NCS)_4]{\cdot}...{\cdot}nHNCS$ is extracted in the organic phase. (tr-auth)

12261 CHEMISTRY OF THE EXTRACTION OF MOLYBDENUM WITH TRIOCTYLAMINE FROM SOLUTIONS CONTAINING PEROXIDE COMPOUNDS. Zelikman, A. N.; Kalinina, I. G. Zh. Neorg. Khim.; 19: No. 4, 1040-1045(Apr 1974). (In Russian).

The mechanism of the extraction of Mo with tri-n-octylamine from peroxide solutions was studied. The methods of isomolar medium, equilibrium displacement, chemical analysis of the compounds formed, and IR spectroscopy were used to establish that the complex $[(C_8H_{17})_3NH]_2MoO_4$ develops in the organic phase. (tr-auth)

12262 RADIOCHEMICAL STUDY OF THE FIXATION OF NEPTUNIUM(IV) BY ZIRCONIUM PHOSPHOSILICATE. Ooms, R. Louvain, Belgium; Univ. Louvain (1974). 59p. (In Dutch). Centre d'Etudes de l'Energie Nucleaire, Mol, Belgium.

Thesis.

The fixation of Np(IV) on zirconium phosphosilicate was studied on a microscopic (^{239}Np) or macroscopic (^{237}Np) scale. Since acid solutions of Np(IV) are not stable, ferrous sulfamate is used as a stabilizer. Neptunium and plutonium can be separated by first fixing the two elements with zirconium phosphate, then carrying out a selective elution of Pu(III) by means of 0.35 M HNO_3 and of Np(IV) by means of 8M HNO_3. At the microscopic scale this method remains difficult because of the degradation of the column. (tr-auth)

12263 EXTRACTION OF RARE-EARTH ELEMENTS BY AMINES. Korpusov, G. V.; Goryacheva, E. G. Nauch. Tr. Gos. Nauch.-Issled. Proekt. Inst.; 42: 123-135(1972). (In Russian).

Studies were made using spectral and radiometric methods of the extraction of rare earths by primary or tertiary amines from chloride, nitrate, sulfate, or thiocyanate solutions; reextraction was made with 1-2 N-HCl or HNO_3. (Referativnyi Zh.)

12264 EXTRACTION OF RARE-EARTH ELEMENTS BY PRIMARY AMINES IN THE PRESENCE OF ETHYLENEDIAMINETETRAACETIC ACID. Korpusov, G. V.; Goryacheva, E. G. Nauch. Tr., Gos. Nauch.-Issled. Proekt. Inst.; 42: 136-147(1972). (In Russian).

Studies were made using gravimetric and spectral methods of the effects of ethylenediaminetetraacetic acid (EDTA) concentration and of solution pH on the extraction of rare-earth elements by primary amines. Re-extraction was made with N NH_4NO_3 solution. The partition coeff. of the heavier elements increases with pH, and attains a value of ~2.0 at pH 7-8; with the lighter lanthanides there is a reverse dependence. (15 references) (Referativnyi Zh.)

12265 SOME REGULAR FEATURES OF THE EXCHANGE OF CATIONS INSIDE THE CAVITIES IN ZEOLITES. Kaliko, M. A.; Lushnikova, T. D.; Zaslavskii, Yu. S. (All-Union Scientific-Research Inst. for Petroleum Processing, Moscow). Kinet. Catal. (USSR) (Engl. Transl.); 14: No. 4, 939-941(1973).

Translated from Kinet. Katal.; 14: No. 4, 1071-1073(1973).

The distribution of the ions Na^+, Ca^{2+}, and La^{3+} (Ce^{3+}) in the structure of an original zeolite Y and its cationic forms CaY and LaY (CeY) has been demonstrated by an ion exchange method. In the partly substituted zeolite CeNaY (degree of exchange ~70%), the greater part of the cations occupy S_2 and S_3 positions. When this form is heated, the Ce^{3+} ions are displaced into S_1 positions. Under the conditions of the production of polyvalent cationic forms of the zeolite with a high degree of exchange, a combination of ordinary "equivalent" exchange from the solutions (rapid stage) and "equi-atomic" exchange of the cations inside the cavity (slow stage) takes place. (auth)

12266 ION EXCHANGE STUDIES ON CRYSTALLINE CERIUM PHOSPHATE AND ARSENATE. Zsinka, L.; Szirtes, L. (Inst. of Isotopes, Budapest). Radiochem. Radioanal. Lett.; 17: No. 4, 257-260(15 Jun 1974).

Investigations were performed with the aim to determine the time required to attain ion-exchange equilibrium. This was found to be 2 hours for all investigated ions at various concentrations both in HCl and NH_4Cl solutions. (auth)

12267 PREPARATION OF HIGH PURITY SULFUR. II. Removal of Trace Amounts of Selenium and Tellurium in Sulfur by Means of Distillation with Silver. Suzuki, H.; Osumi, Y.; Nakane, M.; Miyake, Y. (Government Industrial Research Inst., Osaka). Bull. Chem. Soc. Jap.; 47: No. 3, 757-758(Mar 1974).

In the distillation without silver, most of the selenium and tellurium in crude sulfur appeared in the distillate. However, these impurities were removed by distillation using a column that was filled with silver and heated at 600-700°C. The removal of them in the process was confirmed in a tracer experiment. (auth)

12268 SEPARATION OF Mo AND W BY EXTRACTION WITH D2EHPA. Vol'dman, G. M.; Zelikman, A. N.; Khutoretskaya, I. Sh. (Moscow Inst. of Steel and Alloys). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 2, 97-102(1974). (In Russian).

The reasons for W interference with Mo extraction by di(2-ethylhexyl)phosphoric acid are analyzed mathematically. (tr-auth)

12269 NEPTUNIUM–PLUTONIUM SEPARATION ON INORGANIC ION EXCHANGER ZIRCONIUM PHOSPHOSILICATE. Ooms, R.; Schonken, P.; D'Olieslager, W.; Baetsle, L.; D'Hont, M. (Louvain Univ., Belg.). J. Inorg. Nucl. Chem.; 36: No. 3, 665-670(Mar 1974).

The conditions for sorption and elution of neptunium(IV) from nitric acid solutions on zirconium phosphosilicate (ZPS) have been examined in batch and column experiments. Batch experiments have indicated that the fixation depends strongly on the acid concentration. The separation of Pu and Np can be performed on ZPS by a selective reduction of Pu(III) and Np(IV), respectively, with Fe(II) sulfamate in 0.35 M HNO_3. Only NP(IV) is retained on the ZPS column and can be eluted with 8.0 M HNO_3. (auth)

12270 ROLE OF ADSORPTION AND COCRYSTALLIZATION IN COPRECIPITATION OF MICROAMOUNTS OF THORIUM(IV) AND AMERICIUM(III) WITH BARIUM OXALATE. Bykhovskii, D. N.; Petrova, I. K. Sov. Radiochem. (Engl. Transl.); 15: No. 4, 604-607(1973).

Translated from Radiokhimiya; 15: No. 4, 605-608(1973).

The cocrystallization of the system Th(IV)–$Ba_2C_2O_4$ was studied over a wider range of supersaturations than previously and; the adsorption of thorium onto the surface of the crystals and its behavior during prolonged recrystallization of barium oxalate precipitates was also studied. Data were obtained that made it possible to calculate the distribution coefficients in adsorption and cocrystallization of the Am(III)–BaC_2O_4 system. (LK)

12271 SURFACE AND BULK SORPTION OF STRONTIUM BY BARIUM SULFATE. Vukocich, Zh.; Melikhov, I. V. Sov. Radiochem. (Engl. Transl.); 15: No. 4, 475-481(1973).

Translated from Radiokhimiya; 15: No. 4, 469-475(1973).

Under normal conditions of crystallization of $BaSO_4$ the coprecipitation of strontium proceeds by an adsorption entrapment mechanism. The adsorption entrapment proceeds under liquid phase diffusion conditions during crystallization with a crystal growth rate greater than $5 \cdot 10^{-7}$ cm/sec, with growth rates less than 10^{-7} cm/sec adsorption kinetic conditions are observed if there is no excess of K_2SO_4 in the system and migration conditions when excess of K_2SO_4 is present in the system. The equilibrium distribution coefficient in the system $BaSO_4$–Sr–H_2O determined from data on the local equilibrium between the peripheral zone of the solid phase and the solution equals $B_\infty \simeq 1 \cdot 10^3$. On the surface of growing and stable crystals physical adsorption of Sr is observed with a distribution coefficient $B_A \simeq 5 \cdot 10^3$ and a relaxation time $\theta < 10^{-3}$ sec and also penetration into the surface layer of the solid phase with a distribution coefficient $B_S \simeq 1.5 \cdot 10^4$ and a relaxation time of $\sim 10^2$ sec. (auth)

12272 SORPTION OF STRONTIUM BY BARIUM SULFATE UNDER MIGRATION CONDITIONS. Melikhov, I. V.; Vukovich, Zh. Sov. Radiochem. (Engl. Transl.); 15: No. 4, 482-486(1973).

Translated from Radiokhimiya; 15: No. 4, 476-481(1973).

The sorption of ^{89}Sr by a freshly prepared $BaSO_4$ precipitate obtained by mixing solutions of $BaCl_2$ and K_2SO_4 with concentrations of 10^{-3} M proceeds with rapid diffusion of the impurity into the depth of the sorbent crystals. The mobility of Sr in the volume of the crystals falls as they age because of the movement of defects, which are responsible for the solid-phase diffusion of Sr, to the interphases and their subsequent healing. (auth)

12273 COPRECIPITATION OF PLUTONIUM AND AMERICIUM WITH BARIUM SULFATE Ginzburg, F. L.; Karantsevich, T. S.; Maksimov, V. F. Sov. Radiochem. (Engl. Transl.); 15: No. 4, 487-492(1973).

Translated from Radiokhimiya; 15: No. 4, 481-486(1973).

The conditions for simultaneous coprecipitation of americium and plutonium with $BaSO_4$ at the moment of its formation were studied. It was shown that quantitative coprecipitation occurs from 0.001 M HNO_3 solutions. The plutonium is extracted into solution when the $BaSO_4$ precipitate is treated with $\geq$ 1 M HNO_3 solutions. The desorption of americium under these conditions does not exceed 40–50%. Americium and plutonium entrapped from nitric acid solution by a $BaSO_4$ precipitate in the presence of lanthanum or aluminum nitrate pass into solution practically completely when the precipitate is treated with $\geq$1 M HNO_3 solution. (auth)

12274 COPRECIPITATION OF POLONIUM WITH IRON HYDROXIDE. Ampelogova, N. I. Sov. Radiochem. (Engl. Transl.); 15: No. 4, 493-497(1973).

Translated from Radiokhimiya; 15: No. 4, 487-491(1973).

As a result of an investigation of the effect of the mass of the carrier (iron hydroxide) and the solution pH on the coprecipitation of polonium it was shown that the coprecipitation of polonium does not have an ion exchange mechanism. In the presence of complex forming anions and cations of hydrolyzed metals the degree of coprecipitation of polonium with iron hydroxide is reduced. The hypothesis is put forward that the coprecipitation of polonium with iron hydroxide occurs as a result of cocoagulation of the hydroxides or sorption of hydrolyzed polonium ions with the formation of stable surface compounds. (auth)

12275 SORPTION OF POLONIUM BY MANGANESE DIOXIDE. Ampelogova, N. I. Sov. Radiochem. (Engl. Transl.); 15: No. 4, 498-503(1973).

Translated from Radiokhimiya; 15: No. 4, 491-497(1973).

As a result of an investigation of the sorption and coprecipitation of polonium with MnO_2 in relation to the solution pH and the sorbent mass and the desorption of polonium by various solutions it was established that the sorption of polonium by MnO_2 is irreversible to a considerable degree and depends on the solution pH and the sorbent mass and maximum sorption is observed in the pH region of 1 to 4. The presence of iron and lanthanum cations in the solution produces an appreciable decrease in the sorption of polonium by MnO_2 (at pH = 2-5). The phosphate ion has an analogous effect. On the basis of the results obtained it was concluded that the sorption and coprecipitation of polonium with MnO_2 proceed by the sorption of hydrolyzed forms of polonium with the formation of stable compounds with the sorbent. (auth)

12276 SEPARATION OF RARE-EARTH AND TRANSPLUTONIUM ELEMENTS BY DISTRIBUTION CHROMATOGRAPHY WITH TETRABUTYLHYPOPHOSPHORIC ACID. Korotkin, Yu. S. Sov. Radiochem. (Engl. Transl.); 15: No. 4, 629-630(1973).

Translated from Radiokhimiya; 15: No. 4, 626-626(1973).

Determination of the conditions for separation of the sum of the elements was carried out by distribution paper chromatography on Whatman No. 1 paper. The paper was impregnated with 0.5, 0.1, and 1 M solution of tetrabutylhypophosphoric acid (TBHPA). Elution was carried out with HNO_3 and $HClO_4$. It was established in preliminary experiments that effective separation of the rare-earth elements was possible only with the use of 0.5 M solutions of TBHPA and therefore all experiments were carried out with this concentration of TBHPA. On the basis of the data obtained and literature data conditions were selected for separating a complex mixture of elements on a column of Whatman Chromatography Grade cellulose. The cellulose was first impregnated with 0.5 M TBHPA in acetone and dried in air. The column was washed with the working solution before use. The size of the column was 70 mm × 12.6 mm^2. It should be noted that scandium follows immediately after yttrium, partly overlapping it. A clear peak of scandium is observed only with HNO_3 concentrations $\geq$8 M. Since silver is often used in the oxidation of Np and Pu, its behavior was checked under the same conditions in the work. It was found that silver is not eluted from the column at all at any concentration of acids so that it may be separated readily from fission products. (LK)

12277 GAS CHROMATOGRAPHY OF HIGH-BOILING METAL CHLORIDES USING ALUMINUM CHLORIDE AS COMPLEX FORMER. Zvarova, T. S. Sov. Radiochem. (Engl. Transl.); 15: No. 4, 546-551(1973).

Translated from Radiokhimiya; 15: No. 4, 542-548(1973).

A fundamentally new method of separating mixtures of metals, namely, gas chromatography of chlorides using Al_2Cl_6 vapor as a component of the carrier gas, was proposed and demonstrated. This principle makes it possible to lower substantially the column temperature in the chromatography of volatile chlorides because of the dynamic modification of the surface of the column by absorbed aluminum chloride and, more important, because of the formation of volatile complexes of the metal chlorides with aluminum chloride it is possible to chromatograph at a moderate temperature elements whose chlorides have boiling points right up to 2000°C. An investigation was carried out with 40 elements including Tb, Ce, Lu, Yb, Tm, Np, Sc, Sr, Y, Tc, Ru, Cs, La, Pr, Pm, Eu, Dy, Pa, U, Pu, Am, and Cm that have high-boiling chlorides. The chromatography of most of them is the first case of the chromatography of inorganic compounds of these elements in the gas phase. (auth)

12278 SORPTION OF CATIONIC FORM OF ASTATINE FROM AQUEOUS PERCHLORIC ACID SOLUTIONS BY THE SULTONATE CATIONITE DOWEX-50X8. Tyung, D. K.; Dudova, I. V.; Khalkin, V. A. Sov. Radiochem. (Engl. Transl.); 15: No. 4, 552-556(1973).

Translated from Radiokhimiya; 15: No. 4, 548-553(1973).

Astatine oxidized by dichromate is reversibly sorbed by the monofunctional sulfonated cationite Dowex-50X8 from aqueous solutions of perchloric acid. Over the range of 0.3 M $\leq HClO_4 \leq$ 1.5 M the relation $\log K_d = f(\log[HClO_4])$ is linear. The slope of the line, which is close to −1, indicates that the singly charged positive ion $At(X)^+$ participates in the exchange process. Astatine in the cationic form forms complexes with the chloride ion with the concentration constants $\beta_1 = 1.6 \cdot 10^3$ M^{-1} and $\beta_2 = 2.5 \cdot 10^5$ M^{-2} in 0.5 M $HClO_4$. $At(X)^+$ forms weak complexes (μ = 1.20°) with nitrate (β_1 = 1.35 M), sulfate (β_1 = 1.7 M^{-1} and β_2 = 3.2 M^{-2}), and dichromate ions (β_1 = 22 M^{-1}). The experimental results indicate that the same astatine cation is formed in nitric and perchloric acids after oxidation with dichromate. The relatively high absolute value of the enthalpy of sorption $\Delta H = -3300$ cal/mole leads to the hypothesis that in this case the sorption process is not a normal ion exchange process. (auth)

Inorganic, Organic, and Physical Chemistry

Refer also to abstract 13774.

12279 RAMAN SPECTRA OF GASES. XIII. Two-Quantum Torsional Transitions in Some Dihalo- and Trihaloethanes. Durig, J. R.; Bucy, W. E.; Wurrey, C. J. (Univ. of South Carolina, Columbia). J. Chem. Phys.; 60: No. 8, 3293-3298(15 Apr 1974).

Methyl torsional overtones ($\Delta\nu$ = 2) were observed for CH_3CHCl_2, CD_3CDCl_2, CH_3CHBr_2, CH_3CCl_3, CD_3CCl_3, CH_3CBr_3, CH_3CCl_2F, CH_3CF_2Br, and CH_3CBr_2Cl in the Raman effect. From the observed frequency shifts, barriers to internal rotation have been calculated to be 4.13, 4.13, 4.33, 5.43, 5.40, 5.78, 4.42, 5.06, and 5.70 kcal/mole, respectively. Some of these barriers have never been determined for the gas phase. Trends of barrier height as a function of halogen substitution are discussed for chlorine and bromine substitution (auth)

Chemical and Physicochemical Properties

Refer also to abstracts 12405, 13016, 13097, 13131, and 13135.

12280 (RFP-2170) HEAT OF FORMATION OF PLUTONIUM HYDRIDE. Oetting, F. L.; Horrell, D. R. (Dow Chemical U.S.A., Golden, Colo. Rocky Flats Div.). 27 May 1974. Contract AT(29-1)-1106. 9p. Dep. NTIS $4.00.

The heat of formation of plutonium hydride with plutonium dihydride as the major constituent is -45.6 ± 3.6 kcal/mole. The heat of formation of plutonium hydride having plutonium trihydride as the major constituent is -48.0 ± 3.7 kcal/mole. These values were obtained by measuring heat associated with the following reactions: $Pu(c) + 3H^+ \rightarrow Pu^{+3}(aq) + 1\frac{1}{2} H_2$; $Pu^{+3}(aq) + 2\frac{1}{2} H_2 \rightarrow PuH_2 + 3H^+$; or $Pu(c) + H_2 \rightarrow PuH_2$ for the heat of formation of plutonium dihydride, and $Pu(c) + 3H^+ \rightarrow Pu^{+3}(aq) + 1\frac{1}{2} H_2$; $Pu^{+3}(aq) + 3H_2 \rightarrow PuH_3 + 3H^+$; or $Pu(c) + 1\frac{1}{2} H_2 \rightarrow PuH_3$ for the heat of formation of plutonium trihydride. (auth)

12281 (SRO-810-1) MATHEMATICAL MODELING OF DONNAN DIALYSIS, A CONTINUOUS ION EXCHANGE MEMBRANE PROCESS. Annual Progress Report. Melsheimer, S. S. (Clemson Univ., S. C. (USA)). 31 May 1974. Contract AT(38-1)-810. 28p. Dep. NTIS $4.50.

The mathematical model of Donnan dialysis was extended to include series mass transfer resistances located in the feed channel boundary layer and in the membrane. In order to separate the feed channel and membrane resistances, continuous flow stirred cell experiments were used to independently determine the membrane counterion mass transfer coefficient. The feed channel counterion mass transfer coefficient, along with the coion leakage coefficient and the solvent permeability constant, was determined from operating data on a parallel channel counterflow dialyzer. Insufficient data have been analyzed to permit correlation of these parameters or evaluation of the adequacy of the two resistance model. Preliminary results do indicate that the model is tractible, yielding reasonably consistent parameter values with moderate computation time. The model is programmed in Fortran and utilizes the Hooke-Jeeves Pattern Search algorithm for identifying the parameters by nonlinear regression. The efficiency of solution is significantly improved over earlier single resistance models programmed in CSMP with a Partan regression algorithm. (auth)

12282 BEHAVIOR OF SODIUM AEROSOL IN ATMOSPHERE. Murata, M.; Naritomi, M.; Yoshida, Y.; Kokubu, M. (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 11: No. 2, 65-71(Feb 1974).

Experiments were carried out to determine the behavior of sodium aerosol under various atmospheric conditions, with the view to establishing an air monitoring technique to be used in sodium-cooled fast reactors. Changes in both size and form of sodium aerosol particles released into the air were studied. At levels of humidity below 40%, the particles were observed to be in solid state, constituted of sodium oxides and sodium hydroxide. When sodium aerosol particles are exposed for more than 1 min in an atmosphere containing more than 60% humidity, they are mostly converted into droplets of sodium hydroxide. The size of the droplets increases with humidity, the diameter becoming at 95% humidity about 1.4 times that at 40% (2.7 times in volume). The final state of sodium aerosol suspended in air with a humidity exceeding 90% is in the form of droplets of sodium carbonate. When the CO_2 concentration in the air is as high as 1.0 vol %, the droplets solidify even at a humidity of 70%. The droplets can be made to solidify into grains by dehumidification through air heating. The size of the solid particles thus produced is nearly the same as that of the solid particles observed originally at low humidity, regardless of the level of humidity before heating. (auth)

12283 THE RAMAN SCATTERING OF URANYL AND TRANSURANIUM V, VI, AND VII IONS. Basile, L.J.; Sullivan, J.C.; Ferraro, J.R.; LaBonville, P. (Argonne National Laboratory, Argonne, Illinois 60439). Appl. Spectrosc. 28: No. 2, 142-145 (Mar 1974).

The Raman scattering of U(VI), Np(VI), Pu(VI), Am(VI), and NP(V), Am(V) in $HClO_4$ solutions and Np(VII) in a NaOH medium is reported. Direct observation of the polarized ν_1 vibration ($D_{\infty h}$ symmetry) is observed for the transuranium MO_2^{n+} ions in the V and VI oxidation states. The spectroscopic evidence is consistent with a linear MO_2^{n+} structure for the Np(VII) ion in basic solutions. The trend of of the ν_1 frequency and the MO stretching force constants with the oxidation is discussed and is correlated with the bond strengths and the stability of the MO_2^{n+} ions. (auth)

12284 ELECTRICAL CONDUCTANCE, DENSITY, VISCOSITY, AND SURFACE TENSION DATA. Janz, G.J.; Gardner, G.L.; Krebs, U.; Tomkins, R.P.T. (Molten Salts Data Center, Department of Chemistry, Rensselaer Polytechnic Institute, Troy, N. Y. 12181). J. Phys. Chem. Ref. Data 3: No. 1, 1-116 (1974).

Data on the electrical conductance, density, viscosity, and surface tension of fluoride mixtures have been systematically collected and evaluated. Results are given for 44 binary mixtures over a range of compositions and temperatures. Values of the above properties for the single salts have been updated in accord with previously advanced recommendations. (auth)

Isotope Effects

Refer also to abstracts 13029 and 13749.

12285 CALCULATION OF HEAVY-ATOM KINETIC ISOTOPE EFFECTS: BARRIER CURVATURE AND INTERNAL COORDINATE EFFECTS WITH THREE-ELEMENT REACTION COORDINATES. Wei, G.-J.; Yankwich, P.E. (Department of Chemistry, University of Illinois, Urbana, Illinois 61801). J. Chem. Phys. 60: No. 9, 3619-3633 (1 May 1974).

Effects of barrier curvature and of a restricted method for selection of values for off-diagonal force constants in the transition state were studied by computation for several three-element reaction coordinates assumed for decomposition of formic acid; the temperature independent (TIF) and temperature dependent factors (TDF) of the rate constant ratio $k/k' = k_{12_c}/k_{13_c}$ were calculated. As barrier curvature increases, the area in eigenvector space corresponding to valid transition states decreases in extent and alters in shape; these changes depend on the method of selection of certain secondary off-diagonal force constants. TIF is not affected. TDF is affected, particularly in the part of eigenvector space where the extent of the allowed region is being reduced by barrier curvature. While shapes and values associated with the TIF and TDF surfaces in eigenvector space can be related at least approximately to the input F- and G-matrix properties in some cases, such accounting is generally not accurate in the first order high temperature approximation. (auth)

12286 ISOTOPE EFFECT IN THE CROSS-SECTIONS FOR THE FORMATION OF NEGATIVE IONS BY MOLECULES OF SEVERAL ORGANIC COMPOUNDS. Khvostenko, V. I.; Furlei, I. I.; Aminev, I. Kh.; Mazunov, V. A. (Inst. of Chemistry, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 7: No. 6, 474-478(1973).

Translated from Khim. Vys. Energ.; 7: No. 6, 537-542(1973).

A study was carried out of the isotope effect on the cross-sections for the dissociative capture of electrons by benzene, pyridine, thiophene, and acetone. The isotope effect was greatest for the formation of ions of the type $(M-H)^-$, while a direct isotope effect was also observed for the formation of other fragment ions. It was found that $(M-H)^-$ ions of the compounds studied are formed by dissociative electron capture to give excited autoionization states with finite lifetimes relative to electron detachment. (auth)

12287 HYDROGEN BOND STUDIES. 80. A Deuteron Magnetic Resonance and Infrared Spectroscopic Study of the Water Molecule in Lithium Formate Monohydrate, $LiHCOO \cdot H_2O$. Berglund, B.; Lindgren, J.; Tegenfeldt, J. (Uppsala Univ. (Sweden)). J. Mol. Struct.; 21: No. 1, 135-148(Apr 1974).

A deuteron magnetic resonance and infrared study of the water molecules in lithium formate monohydrate, $LiHCOO \cdot H_2O$, have been made. The quadrupole coupling constants (e^2qQ/h) and asymmetry parameters (η) were found to be 198.7 ± 0.4 and 231.3 ± 0.6 kHz, and 0.060 ± 0.005 and 0.097 ± 0.003, respectively, at 25°C. An interpretation is given of the infrared spectra in the OH-stretching region in terms of intra- and intermolecular couplings of the water molecules. It is found that the water molecules are vibrationally distorted by their environments such that the OH-stretching modes consist of independent stretchings of the two O-H bonds. (auth)

12288 AROMATIC REACTIVITY. LVI. Solvent Isotope Effects in Cleavage of Aryltrimethylstannanes by Acetic Acid and Aryltrimethylsilanes by Trifluoroacetic Acid. Eaborn, C.; Jenkins, I. D.; Walton, D. R. M. (Sussex Univ., Brighton, United Kingdom). J. Chem. Soc., Perkin Trans., II; No. 6, 596-600(1974).

Values of the product isotope effect, corresponding with the product ratio $XC_6H_5 : XC_6H_4D$ obtained on cleavage in a 1:1 SH (ordinary acid)-SD (O-deuteriated acid) medium, have been determined for cleavage of (a) $XC_6H_4SnMe_3$ compounds by acetic acid at 50°, and (b) $XC_6H_4SiMe_3$ compounds by trifluoroacetic acid at 21°. For system (a) the values range from 5.9 for X = p-OMe to 4.9 for X = m-CF_3, and for (b) all the values lie between 6.0 and 6.5. In both systems, for compounds for which the overall solvent isotope effects, given by the ratios of the separate rates in SH and SD media, have also been measured, the overall solvent isotope effects are the same within experimental error as the product isotope effects, indicating that there is no significant secondary solvent isotope effect for the proton transfers from the acids. It is suggested that the proton transfer to form the Wheland intermediate is rather more than half-complete in both cases. In the cleavage of the m-$CF_3C_6H_4MMe_3$ (M = Si or Sn) compounds by trifluoroacetic acid, on average significantly more than one deuterium atom per molecule is incorporated into the benzotrifluoride product, and this anomaly is discussed. (auth)

12289 KINETIC HYDROGEN ISOTOPE EFFECTS IN THE HALOGENATION OF 2-OXOCYCLOHEXANECARBOXYLIC ACID AND ITS METHYL ESTER. Cox, B. G.; Hutchinson, R. E. J. (Sterling Univ., United Kingdom). J. Chem. Soc., Perkin Trans., II; 6: 613-616(1974).

Measurements were made on the rates of bromination of 2-oxocyclohexanecarboxylic acid and of bromination and iodination of methyl 2-oxocyclohexanecarboxylate. The observed rates are independent of the nature and concentration of the halogen involved and represent the rates of ionization or enolization of the substrates. The reactions are base-catalyzed and catalytic constants and kinetic hydrogen isotope effects for some carboxylate anions were determined. Under comparable conditions, 2-oxocyclohexanecarboxylic acid is halogenated 500 to 1000 times more rapidly than is its methyl ester. Observed isotope effects (k_H/k_D) in the halogenation of the acid are high and relatively constant for the bases studied, varying between 7.2 for the uncatalyzed reaction to 8.0 for acetate catalysis. Corresponding values for the ester vary between 4.2 (uncatalyzed) and 7.5 (acetate catalysis). The results indicate a considerable degree of participation of the carboxylic acid group in the halogenation reaction. (auth)

12290 SECONDARY ISOTOPE EFFECT IN THE PHOSPHORYLASE REACTION. Firsov, L. M.; Bogacheva, T. I.; Bresler, S. E. (Inst. of Nuclear Physics, Leningrad). Eur. J. Biochem.; 42: No. 2, 605-609(Mar 1974).

The mechanism of action of phosphorylase B was studied by means of both α-deuterium and α-tritium secondary kinetic isotope effects of the enzymatic reaction. Two pairs of labelled substrates were synthesized: [1-^{3}H] glucose-1-phosphate, [U-^{14}C] glucose-1-phosphate and [1-^{14}C, 1-^{3}H] glucose-1-phosphate with [6-^{3}H] glucose-1-phosphate. The measurements showed that the isotope effects of the enzymatic synthesis of glycogen as well as of the reverse reaction of glycogen phosphorolysis were equal to zero. The secondary α-tritium isotope effect of the acid hydrolysis of glucose-1-phosphate was estimated. The ratio $K_H/K_{^3H}$ in this case was found to be 1.21. These data are consistent with the mechanism of direct displacement at the C-1 atom of glucose and the formation of an intermediate enzyme x glucose-1-phosphate complex depending on the presence of glycogen. (GE)

12291 NUCLEOPHILIC HETEROAROMATIC SUBSTITUTIONS. XXXVII. Aroloxyls as Leaving Groups in Nucleophilic Heteroaromatic Substitution With Piperidine Structural and Hydrogen Isotope Effects. Firani, F.; Illuminati, G.; Sleiter, G. (Univ., Rome). J. Org. Chem.; 39: No. 13, 1888-1891(28 Jun 1974).

The reactivity of a number of 2- and 4-quinolyl aryl ethers with neat piperidine was examined. Product analysis showed that the compounds generally underwent substitution at both the heteroaryl and aryl carbons. The factors favoring the reaction at the aryl carbon are discussed. Where the dearylation reaction could be neglected, the kinetics of the heteroaromatic substitution were carried out. In such cases the kinetic hydrogen isotope effects by the use of N-deuteriopiperidine were also determined, k_H/k_D values as large as 1.96 and 2.46 being obtained for the γ-(2-methyl-4-nitrophenoxy) and the γ-(3-nitrophenoxy) derivative, respectively. The results indicate that the detailed reaction mechanism depends on whether the heteroaromatic substitution takes place at a position α or γ to the aza group. Structure dependence of the isotope effect at the position γ is interpreted in terms of transition-state symmetries. (auth)

12292 VIBRATIONAL ANALYSES AND BARRIER TO INTERNAL ROTATION OF CH_3CHBr_2 AND CD_3CDBr_2. Durig, J. R.; Sloan, A. E.; Thompson, J. W.; Witt, J. D. (Univ. of South Carolina, Columbia). J. Chem. Phys.; 60: No. 6, 2260-2265 (15 Mar 1974).

The infrared spectra of gaseous and solid 1,1-dibromoethane and 1,1-dibromoethane-d_4 were recorded from 140 to 3500 cm^{-1}. The corresponding Raman spectra of the liquid and solids were also recorded and depolarization values measured. All spectra were interpreted in detail and the 18 normal vibrations characterized on the basis of band contours, isotopic shifts, depolarization values, and normal coordinate calculations. The internal torsional mode was observed at 253 cm^{-1} in the far infrared spectrum of gaseous CH_3CHBr_2 and the assignment was confirmed by the shift with deuteration. The threefold barrier to rotation was calculated to be 4.3 kcal/mole. This determination allows a comparison of the barriers for a series of bromoethanes. (auth)

12293 IR SPECTRA OF BF_3 COMPLEX COMPOUNDS AND CALCULATION OF THE EQUILIBRIUM CONSTANTS OF CHEMICAL ISOTOPIC EXCHANGE REACTIONS. Part 3. Complex Compounds of BF_3 With Aliphatic and Saturated Cyclic Ethers. Voloshchuk, A. M.; Katal'nikov, S. G.; Kozik, T. A.; Karetnikov, G. S. (Moscow Chemical-Technological Inst.). Kernenergie; 17: No. 4, 121-123(Apr 1974). (In Russian).

The ir spectra of 10 aliphatic and 2 cyclic ethers and their complex compounds with BF_3 having natural isotopic composition or enriched by ^{10}B to 85% were taken and evaluated. The vibration frequencies obtained from this were applied to calculating the β factors of the corresponding complex compounds. Moreover, the equilibrium constants K were calculated for the isotopic exchange reactions between BF_3 and its complex compounds with the ethers under investigation. The theoretical results sufficiently agree with experimental data for K. (auth)

12294 PHASE SELECTION BY ISOTOPIC SUBSTITUTION IN p-DICHLOROBENZENE CRYSTALS. Colson, S.D.; Wheeler, G.L. (Sterling Chemistry Laboratory, Yale University, New Haven, Connecticut 06520). J. Chem. Phys. 60: No. 11, 4634-4635 (1 June 1974).

Using several experimental techniques the stability of the α and β crystalline phases of p-dichlorobenzene and p-dichlorobenzene-d4 is studied as a functior of growth conditions. The results indicate that the isotope effect is probably a kinetic effect on the phase transition rather than a change in the phase diagram. (AIP)

12295 DETERMINATION OF THE DEUTERIUM QUADRUPOLE COUPLING CONSTANT IN PHOSPHINE-d_3 FROM STUDIES IN A NEMATIC SOLVENT. Zumbulyadis, N.; Dailey, B.P. (Department of Chemistry, Columbia University, New York, New York 10027). J. Chem. Phys. 60: No. 11, 4223-4225 (1 June 1974).

The phosphorus and deuterium Fourier transform NMR spectra of PD_3 in a nematic solvent are reported. The experimentally determined value of the deuterium quadrupole coupling constant is 7.8 ± 0.6 kHz in good agreement with the recent theoretical predictions of Rothenberg, Young, and Schaefer. The ordering parameter is unambiguously determined from the P-D splittings, thus enhancing the accuracy of the present results over previous measurements of this kind. (auth)

12296 TWO-DIMENSIONAL FREE-BOUND FRANCK-CONDON FACTORS. APPLICATION TO INTRAMOLECULAR ISOTOPE EFFECT IN PREDISSOCIATION. Abgrall, H.; Fiquet-Fayard, F. (Laboratoire de Collisions Electroniques (Associé au CNRS), Université Paris-Sud-91, Orsay, France). J. Chem. Phys. 60: No. 11, 4497-4501 (1 June 1974).

We calculate free-bound two-dimensional Franck-Condon factors for a molecule HXD with constant angle HXD. We assume separability into normal modes, but the normal modes are different for the attractive and the repulsive potential surfaces. These Franck-Condon factors can be related to the linewidth of a predissociated level and to the relative probability of dissociation into the channel H+XD or the channel D+XH. Classically, we can predict that the Franck-Condon factor will be a maximum as a function of energy if one of the turning points (for vibration in the bound state) happens to be on the repulsive surface at that energy; furthermore, the location of this turning point on the repulsive surface determines the isotope effect, which can be favorable to either D+XH or H+XD. Our two-dimensional study of the 0-v and v-0 levels shows that these classical predictions are correct, in contrast to the results obtained using a one-dimensional model; in the latter case, strong enhancement of the Franck-Condon factors can occur through interference effects that cannot be predicted classically; interference effects do not show up in the two-dimensional calculation. For the 3-3, 2-2, and 3-2 levels, classical predictions are in rough agreement with the calculations, but we observe strong enhancement of the Franck-Condon factors for certain relative positions of the two surfaces. In conclusion, interference effects do exist for two-dimensional Franck-Condon factors, though they disappear for 0-v and v-0 levels. (auth)

12297 NEW VALUES OF SUBLIMATION ENERGY L_0 FOR NATURAL NEON AND ITS ISOTOPES. McConville, G.T. (Monsanto Research Corporation, Mound Laboratory, Miamisburg, Ohio 45342). J. Chem. Phys. 60: No. 10, 4093-4093 (15 May 1974).

Using recent experimental values of the heat capacity and vapor pressure of ^{20}Ne and ^{22}Ne, new values for the heats of sublimation at absolute zero (L_0) for ^{20}Ne, ^{22}Ne, and natural neon are calculated. A value of L_0 of 462 ± 2 cal/mole is obtained for natural neon. (AIP)

12298 DETERMINATION OF THE ACTIVATION ENERGY FOR THE REACTION $Kr^+(^2P_{3/2}) + H_2(D_2) \rightarrow KrH^+(KrD^+) + H(D)$. Fennelly, P.F.; Payzant, J.D.; Hemsworth, R.S.; Bohme, D.K. (Department of Chemistry and CRESS, York University, Downsview, Ontario, Canada). J. Chem. Phys. 60: No. 12, 5115-5116 (15 June 1974).

Rate coefficients for the reactions $Kr^+(^2P_{3/2})+H_2(D_2) \rightarrow KrH^+(KrD^+)+H(D)$ are measured in a flowing afterglow system at 297°K. The results suggest that there is no significant energy barrier for these reactions. (AIP)

12299 INFRARED SPECTROSCOPIC EVIDENCE FOR MATRIX ISOLATED NITROSYL HYPOFLUORITE, AN ISOMER OF NITRYL FLUORIDE. Smardzewski, R. R.; Fox, W. B. (Naval Research Lab., Washington, DC). J. Chem. Phys.; 60: No. 8, 2980-2986 (15 Apr 1974).

The in situ photolysis of molecular fluorine and NO_2 molecules in nitrogen matrices at 8°K yields the FN-bonded nitryl fluoride, FNO_2, as the primary reaction product. However, controlled fluorine atom diffusion at 20°K, in the absence of photolytic radiation, results in the formation of the highly reactive, FO-bonded, nitrosyl hypofluorite, ONOF. Infrared absorptions at 1716.4, 1199.9, 702.3, and 411.9 cm^{-1} were assigned to this species, which was shown from ^{15}N and ^{18}O isotopic studies to contain two nonequivalent oxygen atoms. The ONOF molecule undergoes intramolecular photorearrangement at wavelengths below 400 nm to produce the more stable FNO_2 form. (auth)

12300 THERMAL REORGANIZATION AND SECONDARY DEUTERIUM ISOTOPE EFFECT STUDIES OF SMALL RING COMPOUNDS. Alonso, J. H. Gainesville, FL; Univ. of Florida (1973). 119p. University Microfilms Order No. 74-9587.

Thesis (Ph. D.).

Three topics were investigated: (1) The synthesis of dideuteriobiscyclopropylidene is reported and its thermal reorganization investigated. The intramolecular isotope effects for the ring opening step and for the cyclization step were determined from NMR analyses of the dideuterated methylenespiropentane products obtained. The ring opening isotope effect k_H/k_D was found to be 1.243 ± 0.035 and the cyclization isotope effect k_H/k_D was found to be 1.136 ± 0.016. The most satisfactory rationalization of these results requires a diradical intermediate and transition states that do not resemble and are less crowded than either product or starting material. (2) The syntheses of 1,1-divinylcyclopropanes d_0, d_2 and d_4 are reported. The activation parameters for the thermal reorganization of the undeuterated 1,1-divinylcyclopropane were determined. The intramolecular isotope effect k_H/k_D determined from the thermal reorganization of 1,1-divinylcyclopropane d_2 was found to be 1.062 ± 0.018 and was estimated from NMR analysis of the dideuterated 1-vinylcyclopentene products. The intermolecular isotope effect k_H/k_D was estimated from the rate constant ratio of undeuterated and tetra deuterated 1,1-divinylcyclopropanes and was found to be 1.08 ± 0.07. A multi-step process is favored on the basis of the isotope effects observed. (3) A novel base-catalyzed ring expansion of some cyclopropylcarbinyl derivatives to the cyclobutene derivatives was also investigated. (Diss. Abstr. Int., B)

12301 DEUTERIUM EFFECT ON THE QUENCHING OF AROMATIC HYDROCARBON TRIPLET EXCITED STATES BY OXYGEN. Benson, R.; Geacintov, N. E. (New York Univ.). J. Chem. Phys.; 60: No. 8, 3251-3257(15 Apr 1974).

By using ultraviolet light flash excitation, the triplet (phosphorescence) decay time τ of a series of protonated (p) and deuterated (d) aromatic hydrocarbons dissolved in a fluffy freeze-dried polystyrene matrix was studied as a function of oxygen pressure $[O_2]$ at 298°K. The quenching constants γ were calculated from linear plots of τ^{-1} as a function of $[O_2]$ and the ratios of $\gamma(p)/\gamma(d)$ are 1.2 ± 0.1 for anthracene and 1,2-benzanthracene, 1.9 ± 0.2 for pyrene, 1.4 ± 0.2 for chrysene, and 2.5 ± 0.4 for naphthalene. These results are interpreted in terms of Franck-Condon factors and the energy transfer quenching model proposed by Kawaoka, Khan, and Kearns in which the $^1\Delta_g$ and $^1\Sigma_g^+$ excited states of oxygen are generated, and in which the remaining energy is dissipated by the vibrational modes of the quenched aromatic molecules. In pyrene and in naphthalene, the $^1\Delta_g$ pathway appears to be more important than in chrysene and dominates over the $^1\Sigma_g^+$ mechanism. No conclusions can be reached about the preferred mode of energy transfer to oxygen in anthracene and 1,2-benzanthracene. (auth)

Isotope Exchange and Isotope Separation

Refer also to abstracts 12368 and 13029.

12302 DETERMINATION OF THE SURFACE COMPOSITION OF CALCITE IN Mg^{2+}-CONTAINING ^{45}Ca-LABELLED SOLUTIONS. Moeller, P. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). (1973). vp. (In German).

From meeting of the Gesellschaft Deutscher Chemiker on trace analysis; Erlangen, Germany (2 Apr 1973).

The process, proposed to determine the chemical composition of surfaces of hard-to-dissolve substances in solutions containing foreign ions, assumes an equilibrium of the ions involved between the surface and the solution. Knowledge of this dependence and in particular of its influence by other ions, permits the surface composition to be determined in simple systems by determining the content of the ions concerned in the solution. As this exchange, as far as calcite is concerned, is limited to a unimolecular layer, it is possible using this indirect method to determine the surface composition under conditions which are unobtainable by a direct route or application of physical and chemical methods. (GE)

12303 ANALYSIS OF KINETIC MODELS FOR HETEROGENEOUS ISOTOPE EXCHANGE. Toth, G.; Galina, F. (Technical Univ., Budapest). Radiochem. Radioanal. Lett.; 17: No. 4, 261-266(15 Jun 1974).

A model was set up for the solid/liquid phase isotope exchange kinetics on the basis of the Freundlich-type energetic non-uniformity. The superposition of a great number of first-order rate equations was analyzed by a computer program. (auth)

12304 CALCULATION OF THE FRACTION OF EXCHANGE FOR HETEROGENEOUS UNSTABLE SYSTEMS. II. Formation of the Solid Phase. Ghattas, N. K. (Atomic Energy Authority, Cairo). Radiochem. Radioanal. Lett.; 17: No. 4, 275-279(15 Jun 1974).

Modified equation, depending mainly on radiometric data, was derived for the calculation of the rate of progress of heterogeneous exchange reaction. The fraction of exchange for unstable systems, in which the solid phase is forming during the experiment, was also calculated. (auth)

12305 CALCULATION OF THE FRACTION OF EXCHANGE FOR HETEROGENEOUS UNSTABLE SYSTEMS. I. Dissolution of the Solid Phase. Ghattas, N. K. (Atomic Energy Authority, Cairo). Radiochem. Radioanal. Lett.; 17: No. 4, 267-274(15 Jun 1974).

In the present work, modified equations for the calculation of the fraction of exchange for heterogeneous unstable systems are derived. The inactive solid phase is dissolving during the experiment. (auth)

12306 ISOTOPIC EXCHANGE STUDY OF THE SURFACE REACTIONS OF CARBON MONOXIDE WITH MANGANESE DIOXIDE. Kasatkina, L. A.; Nekipelova, L. G. (Moscow Chemical Technological Inst.). Kinet. Catal. (USSR) (Engl. Transl.); 14: No. 4, 877-881(1973).

Translated from Kinet. Katal.; 14: No. 4, 1003-1009(1973).

Study has been made of the homomolecular isotopic exchange in CO (1) on vacuum degassed MnO_2, working over the temperature interval from -78 to 200°C and with CO pressure of 20 torr. Homomolecular exchange proceeds rapidly under these conditions and is accompanied by exchange between CO and the oxygen of the catalyst (2). MnO_2 is reduced during this process. The results obtained here indicate that adsorbed CO forms various surface compounds with MnO_2. Reduction of MnO_2 in the course of CO exchange at 200°C leads to the formation of Mn_3O_4 which is also quite active in the exchange reactions. The exchange rate falls with increasing time of CO contact, on both MnO_2 and Mn_3O_4. (auth)

12307 HOMOMOLECULAR HYDROGEN EXCHANGE ON FILMS OF RARE EARTH METALS. Zhavoronkova, K. N.; Korabel'nikova, L. M. (Moscow Chemical Technological Inst.). Kinet. Catal. (USSR) (Engl. Transl.); 14: No. 4, 844-847(1973).

Translated from Kinet. Katal.; 14: No. 4, 966-969(1973).

Catalytic activity of thin vacuum sputtered films of the rare-earth metals, yttrium, gadolinium, dysprosium, and ytterbium was studied with respect to low-temperature ortho-para hydrogen conversion and isotopic exchange in molecular hydrogen. A relation was found to exist between the catalytic activities of these metals and their atomic magnetic moments. (auth)

12308 BASE-CATALYZED PROTIUM-DEUTERIUM EXCHANGE IN BICYCLO[2.2.1]HEPTANONES. Taillefer, R. J. Hamilton, Ont.; McMaster Univ. (1973). National Library of Canada, Ottawa.

Thesis (Ph. D.).

Several ketones in the bicyclo[2.2.1]heptane system, many of them previously unknown, were prepared and characterized; these included monoketones, enones and diones. The conformations of norbornane-2,5-dione and 3,3-dimethylnorbornane-2,5-dione have been carefully examined by nuclear magnetic resonance spectroscopy. These compounds have been found to exist in two different synchro twist conformations. The stereochemistry of base-catalyzed protium-deuterium exchange in the diones has been examined and found to be similar to the stereochemistry of exchange in monoketones previously observed in these systems, viz exo exchange is considerably more rapid than endo exchange. The rates of NaOD-catalyzed protium-deuterium exchange of the ketones have been measured in 60% dioxane-D_2O at 25°. The rate data was found to be as follows; exo rate is listed first, then the endo rate: norcamphor, 3.85×10^{-2}, 5.90×10^{-5}; norbornane-2,5-dione, 4.7, 3.54×10^{-2}; 5-methy

lene-2-norbornanone, 3.42×10^{-1}, 1.24×10^{-4}; 6-methylene-2-norbornanone, 6.27×10^{-2}, 1.30×10^{-4}; 6, 6-dimethyl-2-norbornanone, 1.64×10^{-2}, 2.62×10^{-5}; 3,3-dimethylnorbornane-2,5-dione, 6.6, 3.89×10^{-2}; 5-methylene-6,6-dimethyl-2-norbornanone, 1.31×10^{-1}, 7.48×10^{-5}; epiisofenchone, 9.88×10^{-3}, 2.53×10^{-5}; fenchane-2,5-dione, 2.0, 4.57×10^{-2}; 4,6,6-trimethyl-5-methylene-2-norbornanone, 6.80×10^{-3}, 7.28×10^{-4}. The rate data, together with some literature data, show that hybridization effects, torsional effects, conformational effects and strain effects are of minor importance in the exchange reactions. The rate acceleration observed in the dione systems, is almost entirely accountable by an inductive effect of the second carbonyl group, with very little homoconjugative participation. The kinetic results suggest that an enol is the intermediate in the enolization reaction, and that the transition state occurs relatively early along the reaction coordinate. (Diss. Abstr. Int., B)

12309 CORRECTIONS TO THE BORN–OPPENHEIMER APPROXIMATION AND ELECTRONIC EFFECTS ON ISOTOPIC EXCHANGE EQUILIBRIA. II. Kleinman, L.I.; Wolfsberg, M. (Department of Chemistry, University of California, Irvine, California 92664). J. Chem. Phys. 60: No. 12, 4740-4748 (15 June 1974).

If nonadiabatic effects are neglected (the adiabatic approximation), the potential energy for the motions of the nuclei of a molecule is the sum of the Born–Oppenheimer electronic energy and the adiabatic correction (diagonal nuclear motion correction). This adiabatic correction has been evaluated at the experimental equilibrium internuclear separation for a number of first- and second-row diatomic hydrides and deuterides. The electronic wavefunctions which have been used in these calculations are LCAO MO SCF functions which range in quality from so-called minimum basis set functions to so-called near–Hartree–Fock functions. The explicit R dependence of the LCAO coefficients has been taken into account. The adiabatic corrections to the electronic energy are functions of the nuclear masses. With the assumption of the distance independence of the adiabatic correction, the calculations here can be used to evaluate the effect of the adiabatic correction on the equilibrium constants for the isotopic exchange reactions $HX+HD=DX+H_2$. For the HX systems on which calculations were done here, these correction factors range, with good single configuration wavefunctions, from 0.963 to 1.113 at 300°K. (auth)

12310 SHIFTS IN VIBRATIONAL CONSTANTS FROM CORRECTIONS TO THE BORN–OPPENHEIMER APPROXIMATION: EFFECTS ON ISOTOPIC EXCHANGE EQUILIBRIA. Kleinman, L.I.; Wolfsberg, M. (Department of Chemistry, University of California, Irvine, California 92664). J. Chem. Phys. 60: No. 12, 4749-4754 (15 June 1974).

The adiabatic correction to the Born–Oppenheimer approximation has been evaluated as a function of internuclear separation for the diatomic molecules in the isotopic exchange reaction $HX+HD=DX+H_2$, where X=D, Li, or Cl. The sum of the isotope-dependent adiabatic correction and the isotope-independent Born–Oppenheimer electronic energy is the effective potential energy for nuclear motion if nonadiabatic effects are neglected. The resulting shifts, from the Born–Oppenheimer values, of the equilibrium internuclear separations and of other vibrational constants are calculated. It is found that these shifts are so small that they have negligible effect on calculated values of the isotopic exchange equilibrium constants. The only important contribution of the adiabatic correction to the equilibrium constants arises from the fact that the ΔE of the isotopic exchange reactions between translationless, rotationless, vibrationless reactants and corresponding products no longer equals zero. (auth)

12311 ISOTOPE EXCHANGE OF SODIUM IN Na_2ZrSiO_5. Chukhlantsev, V. G. Sov. Radiochem. (Engl. Transl.); 15: No. 4, 563-566(1973).

Translated from Radiokhimiya; 15: No. 4, 560-563(1973).

It was established that the rate of exchange of sodium ions in Na_2ZrSiO_5 at 403–503°K is determined by self-diffusion. Two phases of the exchange differing in the rate constants were found. It is probable that Frenkel defects are readily formed because of the presence of void-channels in the Na_2ZrSiO_5 lattice, while the replacement of some of the sodium ions in the lattice by hydrogen ions leads to the appearance of Schottky defects. (auth)

12312 STUDY OF STABILIZATION OF IODINE CRYSTALS BY ISOTOPIC EXCHANGE. Berdonosov, S. S.; Komarevskii, V. M.; Melikhov, I. V. Sov. Radiochem. (Engl. Transl.); 15: No. 4, 567-571(1973).

Translated from Radiokhimiya; 15: No. 4, 564-569(1973).

An investigation was made of the properties of iodine crystals formed by mass crystallization from the vapor by means of isotope exchange, diffractometry, pycnometry, microscopy, and adsorption of krypton. This led to the hypothesis that in the stabilization of crystals, which occurs during their prolonged storage, within the initially uniform defect crystals there is formed a system of defect zones containing vacancies and voids that connects with the surface. Through this system of zones a tracer may penetrate comparatively rapidly (self-diffusion coefficient of about 10^{-9} cm^2/sec) from the surface deep into the stabilized crystals. (auth)

Feed Materials Processing

12313 (AAEC/E-282) PRODUCTION OF SINTERABLE URANIUM DIOXIDE FROM AMMONIUM DIURANATE. Part I. A Review of Gas/Solid Contractors. Fane, A. G. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Apr 1974. 34p. Dep. NTIS (US Sales Only) $4.75.

Performance characteristics of a variety of contractors used for gas/solid reactions are reviewed. A critical assessment is made of their suitability for the conversion of ammonium diuranate to sinterable uranium dioxide in terms of their heat transfer and powder handling characteristics, and the capability of obtaining a high conversion efficiency consistent with continuous operation. The pulsed fluidized bed is judged to be particularly promising for future development. (auth)

Radiation Chemistry

Refer also to abstracts 12376, 12377, 12383, 12826, 12856, and 13276.

12314 (EUR-5122(Vol.1), pp 279-314) JOINT PROCESSING OF PHENOMENA DEPENDENT OR NON-DEPENDENT ON RADIATION AND STUDIES OF THEORETICAL MODELS. Delattre, P. (CEN de Saclay, Gif-sur-Yvette, France). Mar 1974. (In French).

From fourth symposium on microdosimetry; Verbania, Italy (24 Sep 1973).

The effects of radiation on chemical and biological systems manifest themselves by phenomena directly caused by radiation (ionization, excitation, molecular ruptures, etc ...) and phenomena depending on the intrinsic properties of the materials studied (recombination, de-excitation, recovery, etc ...). If we want to explain the effects, as we observe it, it is necessary to simultaneously treat the different types of process occurring; an adequate conceptual and theoretical framework is thus necessary. The formalism proposed at the 3rd Symposium on Microdosimetry in 1971 meets these requirements; if this formalism is adopted, it is then necessary to know how a theoretical model can be developed from the experimental results. It is this problem that is dealt with in the present report. Only linear models are treated and great emphasis is put on the precautions necessary to avoid models containing information unrelated to the experiment. Particular attention is given to the problem of the relations between the actual properties of elements in the system studied and the properties utilized for identifying these elements. Once a theoretical model has been established, which generally contains both transformations dependent and transformations independent of radiation, close collaboration between physicists, chemists, and biologists can lead to a microscopic interpretation of the results obtained. (auth)

12315 (EUR-5122(Vol.1), pp 463-476) EXCITATION ENERGY AND OXYGEN EFFECT. Preliminary Study on Molecules of Biological Interest. Rocquet, G.; Fontenil, L.; Champel, P.; Mignot, M. Mar 1974. (In French).

From fourth symposium on microdosimetry; Verbania, Italy (24 Sep 1973).

The effect of oxygen on the radiolysis of LiBr, tryptophane, and N-acetyltryptophane in aqueous solution was studied. The relation between radiolysis and photolysis of these solutions was also investigated. Preliminary results giving the radiolysis and photolysis curves are presented. The results showed that in the absence of oxygen no effect due to the singlet-triplet conversion was observed in LiBr. In the presence of oxygen a parallelism can be established with photolysis. These results indicate that the effects from the excitation energy produced during radiolysis of aqueous solutions should be considered in the explanation of the primary mechanism of radiobiological effects. (JSR)

12316 (TID-26590) KINETICS OF THE RADIATION INDUCED DECOMPOSITION OF SODIUM NITRATE. Frances, A. (Maryland Univ., College Park (USA). Dept. of Chemical Engineering). 1974. 189p. Dep. NTIS $12.50.

Thesis.

It has been observed that the concentration of total reducing species (nitrite included) formed in the radiolytic decomposition of sodium nitrate (and other nitrates) is always greater than the amount of nitrite produced. It has been determined that this difference is due to a color center (presumably O_3^-) tightly bound to an intermediate complex. The rate of the radiolytic decomposition of sodium nitrate has been found to be extremely dependent upon the concentration of nitrite in the sodium nitrate lattice

up to a concentration of about 0.2 μmole NO_2^-/g $NaNO_3$, after which the rate of decomposition approaches a steady state value. This is explained by the simultaneous occurrence of two reaction paths in the decomposition of sodium nitrate. One of these paths involves the decomposition via excitation or ionization to yield nitrite ion and oxygen and is proportional to absorbed dose. The other reaction path involves decomposition of the nitrate ion by an energy transfer mechanism. This path also yields NO_2^- and O_2, the rate of which decreases with increasing concentration of the nitrite ion. This effect appears to persist up to a nitrite concentration of about 0.2 μmole NO_2^-/g $NaNO_3$. It was further observed that $NaNO_3$ decomposition exhibits an unusual temperature dependence with $G(NO_2^-)$, having a minimum value at about 0°C. It was found that a phase transition occurs in the sodium nitrate lattice between −5 and −30°C which adequately explains this unusual temperature dependence of the decomposition. (auth)

12317 (TID-26593) RADIATION INDUCED DECOMPOSITION OF INORGANIC MOLECULAR IONS. Progress Report, Johnson, E. R. (Maryland Univ., College Park (USA). Dept. of Chemical Engineering). [nd]. Contract AT(40-1)-3660. 5p. Dep. NTIS $4.00.

Progress is reported in studies on the mechanism of the radiation-induced decomposition of $NaNO_3$ and on the fixation of atmospheric nitrogen to form nitrates. (LK)

12318 CHEMILUMINESCENT REACTIONS AFTER PULSE RADIOLYSIS OF AQUEOUS DYE SOLUTIONS. Absolute Yields. Prutz, W. A. (Universite de Freiburg i.B.); Land, E. J. J. Phys. Chem.; 78: No. 13, 1251-1253(20 Jun 1974).

The number of fluorescence quanta emitted per reaction [dye (oxidized by ·OH) + e_{aq}^-], denoted ϕ_{ch}, was estimated for several dyes. Two standards were used involving high energy irradiation: (A) Cherenkov light induced fluorescence of the dye itself, (B) p-terphenyl fluorescence in benzene. Both methods agreed within experimental error and gave mean values of ϕ_{ch} for Acriflavin, Rhodamine B, Fluorescein (at pH 10), and anthranilic acid of 0.011, 0.018, 0.031, and 0.020, respectively. (auth)

12319 CONFIGURATION COORDINATE MODEL FOR THE HYDRATED ELECTRON. III. DIFFUSIVE MOTION. Tachiya, M. (Radiation Laboratory, University of Notre Dame, Notre Dame, Indiana 46556). J. Chem. Phys. 60: No. 6, 2275-2277 (15 Mar 1974).

The diffusive motion of the solvated electron is treated by use of the configuration coordinate model. The configuration coordinate diagram appropriate to the diffusive motion of the hydrated electron is constructed by calculating the total energy of the hydrated electron under a series of orientational polarization functions which are appropriately chosen. The diffusive motion of the hydrated electron is discussed in terms of this diagram. The calculated activation energy of diffusion is 0.16 eV, which is in excellent agreement with experiment. (auth)

12320 EFFECT OF FAST NEUTRON, GAMMA-RAY, AND COMBINED RADIATIONS ON THE THERMAL DECOMPOSITION OF AMMONIUM PERCHLORATE SINGLE CRYSTALS. Herley, P.J.; Wang, C.S. (State University of New York at Stony Brook, Stony Brook, New York 11790); Varsi, G.; Levy, P.W. J. Chem. Phys. 60: No. 6, 2430-2439 (15 Mar 1974).

The thermal decomposition kinetics have been determined for ammonium perchlorate crystals subjected to a fast neutron irradiation or to a fast neutron irradiation followed by a gamma-ray irradiation. Qualitatively, the radiation induced changes are similar to those obtained in this and in previous studies, with samples exposed only to gamma rays. The induction period is shortened and the rate constants, obtained from an Avrami-Erofeyev kinetic analysis, are modified. The acceleratory period constant increases and the decay period constant decreases. When compared on an equal deposited energy basis, the fast neutron induced changes are appreciably larger than the gamma-ray induced changes. Some, or all, of the fast neutron induced effects might be attributable to the introduction of localized regions of concentrated radiation damage ("spikes") by lattice atom recoils which become thermal decomposition sites when the crystals are heated. (auth)

12321 FREE RADICAL FORMATION IN x-IRRADIATED HISTIDINE HCl. Ngo, F.Q.; Budzinski, E.E.; Box, H.C. (Biophysics Department, Roswell Park Memorial Institute, Buffalo, New York 14203). J. Chem. Phys. 60: No. 9, 3373-3377 (1 May 1974).

ENDOR spectroscopy was used to identify three primary radicals in single crystals of histidine hydrochloride x irradiated at 4.2°K. Oxidation leads to decarboxylation producing the radical $R–CH_2–\dot{C}H–NH_3^+$, where R stands for the protonated imidazole ring. Another oxidation product is produced by removal of an electron from the imidazole ring. The reduction process yields a carboxyl anion by addition of an electron to the carbonyl oxygen. ENDOR spectroscopy was also used to characterize more completely the final hydrogen-adduct radical that is obtained on warming the crystals to room temperature. (auth)

12322 FORMATION OF N_2F_4 BY THE RADIOLYSIS OF LIQUID NF_3. Dmitrievskii, V. A.; Il'in, E. K.; Migachev, A. I. High Energy Chem. (USSR) (Engl. Transl.); 7: No. 6, 496-497(1973).

Translated from Khim. Vys. Energ.; 7: No. 6, 557-558(1973).

Liquid nitrogen trifluoride was irradiated with 800-keV electrons at an electron current of 200 μA, using a nickel vessel of 50 mm diameter and 90 mm height immersed in liquid nitrogen. The thickness of the liquid NF_3 layer was ~5 mm. A ballast volume of ~1 liter was connected to the vessel. The NF_3 was irradiated for a given time and the gaseous products then removed at −150°C. At −20° the total pressure of the remaining substances was measured and their concentrations determined by gas−liquid chromatography. A small quantity of difluorodiazine was detected, but the main component was tetrafluorohydrazine, which was separated from the mixed products by repeated distillation. The molecular weight, vapor pressure, IR spectrum, and mass spectrum of this product were the same as those for a standard sample of tetrafluorohydrazine. (LK)

12323 GAMMA-RADIATION-INITIATED OXIDATION AND ISOMERIZATION OF CYCLODODECANOL. Ladygin, B. Ya. (State Scientific-Research and Planning Inst. for the Nitrogen Industry and Products of Organic Synthesis, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 7: No. 6, 494-495(1973).

Translated from Khim. Vys. Energ.; 7: No. 6, 555-557(1973).

Samples of cyclododecanol were irradiated with ^{60}Co γ-rays in glass vessels, either under vacuum or in an oxygen stream. The products formed during the gamma-radiation-initiated oxidation and isomerization of cyclododecanol were studied. (LK)

12324 EFFECT OF HIGH-ENERGY PROTONS ON POLYETHYLENE. Goryachev, A. N.; Pankratova, L. N. (Scientific-Research Inst. of Nuclear Physics, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 7: No. 6, 488-489(1973).

Translated from Khim. Vys. Energ.; 7: No. 6, 551-552(1973).

The effect of 6.5-MeV protons on a pack of high-density polyethylene films was studied as a function of the depth of penetration. The film packs (6.17 mg/cm²) were irradiated to doses of 1, 2, 3, 4.5, 6, and 7.5×10^{14} R/cm². The yield of trans-vinylene double bonds reaches a maximum at a depth of 34−35 mg/cm² and then decreases. (LK)

12325 EFFECT OF TEMPERATURE ON THE RECOMBINATION OF ION-ELECTRON PAIRS FORMED IN THE RADIOLYSIS OF N-HEXANE. I. Isolated Pairs. Arshakuni, A. A.; Byakov, V. M.; Pichuzhkin, V. I.; Saraeva, V. V. High Energy Chem. (USSR) (Engl. Transl.); 7: No. 6, 523-527(1973).

Translated from Khim. Vys. Energ.; 7: No. 6, 523-527(1973).

The effect of temperature on the capture of electrons by heptyl chlorides in the liquid-phase radiolysis of n-hexane was studied. The efficiency of electron capture by scavengers decreases with increasing temperature, while the efficiency of ion−electron pair recombination increases. Consideration of the results in the framework of the theory of isolated ion−electron pairs leads to the conclusion that the parameter D/k_s, where D is the sum of the diffusion coefficients of the electrons and positive ions and k_s is the rate constant for reaction of the electron with the scavenger, increases with increasing temperature. At low temperatures electron scavenging is determined by diffusion, at high temperatures by the kinetic stage of the process. (auth)

12326 RADIOLYSIS OF MULTILAYERS OF ANTHRACENE ON SOLID SURFACES. Doroshenko, V. N.; Cheravetsova, I. N.; Kabakchi, A. M. (Inst. of Physical Chemistry, Kiev). High Energy Chem. (USSR) (Engl. Transl.); 7: No. 6, 459-461(1973).

Translated from Khim. Vys. Energ.; 7: No. 6, 519-522(1973).

Measurements of the degree of photoluminescence quenching were used to study the radiation chemical conversions of anthracene on surfaces of quartz, lime silicate glass, and KCl and KI single crystals on exposure to ^{60}Co γ-rays. The calculated thickness of the adsorbed substance was varied from $1 \cdot 10^{-4}$ to $3.2 \cdot 10^{-3}$ mg/cm². It was found that in layers up to $7 \cdot 10^{-4}$ mg/cm² thickness, which are directly adjacent to the support, the radiolysis of anthracene is appreciably greater than in thicker layers. This effect is greatest with quartz, the surface of which contains significant quantities of silanol groups capable of radiolytic decomposition to ≡SiO· radicals and H atoms. In thicker layers an increased radiolytic conversion was detected only on KI, which has a high effective number. It is suggested that in this case the increase is caused by secondary electrons originating in the support. (auth)

12327 INVESTIGATION OF THE RADIOLYSIS OF SOLID ORGANIC HYDROXY COMPOUNDS. I. Study of Radiation Defects by a Chemiluminescence Method. Klimentov, A. S.; Mikhal'chenko, G. A. (Leningrad Technological Inst.). High Energy Chem. (USSR) (Engl. Transl.); 7: No. 6, 454-458(1973).

Translated from Khim. Vys. Energ.; 7: No. 6, 513-518(1973).

Crystalline polyatomic alcohols and carbohydrates were exposed

to α-, β-, and γ-radiations in air. The irradiations were carried out at 293°K. It has been shown that radicals can be detected with high efficiency by a chemiluminescence method. Free radicals in solid hydroxy compounds have a 60% probability of stimulating the chemical conversion of a chemiluminescent indicator introduced into the solution. During radiolysis, radicals are generated in poly-crystalline hydroxy compounds in proportion to the absorbed dose. Increasing the LET of the radiation reduces the rate of radical formation. A mechanism is proposed for the reaction of radicals with luminol in solution. (LK)

12328 REACTIVITY OF NEPTUNIUM AND PLUTONIUM IONS RELATIVE TO THE HYDRATED ELECTRON IN AQUEOUS ALKALINE SOLUTIONS. Pikaev, A. K.; Mefod'eva, M. P.; Krot, N. N.; Spitsyn, V. I. (Inst. of Physical Chemistry, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 7: No. 6, 448-450(1973).

Translated from Khim. Vys. Energ.; 7: No. 6, 505-508(1973).

Using pulse radiolysis methods and optical recording of the short-lived particles, measurements were made of the absolute rate constants for the reactions of e^-_{aq} with the ions Np(V), Np(VI), Np(VII), Pu(VI), and Pu(VII) in aqueous alkaline solutions at room temperature. It was found that the hexa- and heptavalent ions of neptunium and plutonium are highly reactive with e^-_{aq}, while the rate of reaction of Np(V) ions under identical conditions is 2 to 6 times smaller. In particular, in a 2M NaOH solution the rate constants for reactions of e^-_{aq} with Np(V), Np(VI), Np(VII), Pu(VI), and Pu VII are $6.1 \cdot 10^8$, $1.2 \cdot 10^{10}$, $2.1 \cdot 10^{10}$, $1.9 \cdot 10^{10}$, and $4.2 \cdot 10^{10}$ liter/mole · sec, respectively. When $[OH^-] \geq 7.5$ M the rate constants are appreciably lower. An explanation of the observed facts is presented. (auth)

12329 ESR STUDY OF THE LOW-TEMPERATURE RADIOLYSIS OF INCLUSION COMPOUNDS OF MONOBUTYLAMINE AND DIBUTYLAMINE WITH UREA. Telkova, T. N.; Karasev, A. L.; Bakh, N. A. (Inst. of Electrochemistry, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 7: No. 6, 444-447(1973).

Translated from Khim. Vys. Energ.; 7: No. 6, 500-504(1973).

In order to identify radicals formed in monobutylamine (MBA) and dibutylamine (DBA), inclusion compounds of these amines with urea were used. In inclusion compounds the molecules are isolated from one another and have a greater freedom of rotation around the longitudinal axis of the molecule than in a matrix of the pure amine. Stabilized electrons, aminoalkyl radicals ($R\dot{C}HNHR'$), and alkylamine radicals ($R\dot{N}R'$) were identified in the γ-irradiated inclusion compounds. On the basis of differences in the thermal stability of the alkylamine radicals in the inclusion compounds of MBA and DBA with urea it was concluded that the transition of an alkylamine radical into a aminoalkyl radical requires the hydrogen atom abstraction reaction $RCH_2\dot{N}H + NH_2CH_2R \rightarrow RCH_2NH_2 + NH_2\dot{C}HR$, while the probability of the isomerization reaction $RCH_2\dot{N}H \rightarrow RCHNH_2$ must be small. (auth)

12330 ESR STUDY OF THE LOW-TEMPERATURE RADIOLYSIS OF ALKYLAMINES. Telkova, T. N.; Karasev, A. L.; Bakh, N. A. (Inst. of Electrochemistry, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 7: No. 6, 440-443(1973).

Translated from Khim. Vys. Energ.; 7: No. 6, 496-499(1973).

ESR techniques were used to study the radiolysis of normal and tertiary monobutylamines (MBA, tertMBA), normal, di- and tributylamines (DBA, TBA). In MBA and DBA the radicals $R\dot{N}R'$ and $C_3H_7\dot{C}HNR'R''$ were identified. In TBA aminoalkyl radicals having optical absorption spectra below 400 nm were observed. In tert-MBA the tert-butyl radical $(CH_3)_3\dot{C}$ and $(CH_3)_3C\dot{N}H$ were identified. In MBA and tert-MBA the alkylamine radicals are not stable at higher temperatures, whereas in DBA these radicals have the same stability as aminoalkyl radicals. From the results it could be concluded that in MBA and DBA hydrogen atoms are abstracted from the α-position with respect to the amino group and also from the amino group; in tert-MBA C—N bond rupture occurs, unlike MBA, DBA, and TBA. In TBA the principal process is radical formation of C—H bond rupture in the hydrocarbon chain. (auth)

12331 RADIATION PURIFICATION OF POLLUTED WATER FROM ORGANIC CONTAMINANTS. Dolin, P. I.; Shubin, V. I.; Brusentseva, S. A.; Pribush, A. G. (Inst. of Electrochemistry, Moscow). Vodosnabzh. Sanit. Tekh.; 8: 10-14(1973). (In Russian).

A number of factors must be considered during an evaluation of the radiation process for water purification: the concentration and nature of the contaminants, the desired resultant purity, the nature and concentration of the products of radiation-induced oxidation, and the volume of water to be purified. The effects of dosages and temperatures, various pathways, and possible reactive species such as OH, H, H_3O^+, and HO_2 are considered. Yields are given for various products under varying conditions. Radiation purification may be an economic way to purify dilute (less than 10^{-3} M) solutions of highly toxic compounds. The optimum conditions for the removal of organic material from aqueous solutions by the chain mechanism were determined. Recommendations were made for future studies such as the relationship of oxidation to polymerization and polycondensation; radiation treatment followed by biological purification and others. (JPRS)

12332 FORMATION OF 1.4-PYRONES ON IRRADIATION OF STARCH. Scherz, H. (Bundesforschungsanstalt fuer Lebensmittelfrischhaltung, Karlsruhe, Ger.). (1973). vp. (In German).

From Meeting of the Gesellschaft Deutscher Chemiker on trace analysis; Erlangen, Germany (2 Apr 1973).

In developing processes to distinguish between irradiated and non-irradiated food, radiolysis products of starch being highly radiospecific were chosen. In attempting to show that a carbohydrate containing foodstuff had been irradiated, the formation of 1,4-pyrone was found by the effect of energy-rich radiation on starch in an ethyl acetate-acetone-water solvent mixture. (GE)

12333 RADIOLYSIS OF RADIOPHARMACEUTICAL COMPOUNDS: AQUEOUS SOLUTIONS OF O-IODOHIPPURATE-^{131}I AND O-IODOBENZOATE-^{131}I. Potapova, Z. M.; Kharlamov, V. T.; Pikaev, A. K.; Gus'kov, A. F. (Inst. of Biophysics, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 7: No. 6, 451-453(1973).

Translated from Khim. Vys. Energ.; 7: No. 6, 509-512(1973).

The γ-radiolysis of aqueous solutions of o-iodohippurate-^{131}I and o-iodobenzoate-^{131}I was studied. It was found that irradiation to a dose of 0.2-4.4 Mrad causes a significant decrease in their concentrations. The main radioactive radiolysis products are ^{131}I-iodide ions, the concentration of which increases with increasing dose. One other radioactive product is obtained from the benzoate, two others from the hippurate. Nonradioactive radiolysis products found were the corresponding hydroxy acids and glycine. The radiation-chemical yields for the decomposition of the starting substances and for the formation of iodide ions were calculated. A radiolysis mechanism is proposed. (auth)

12334 RADIOLYSIS OF TRYPTOPHANE IN PENAEUS SETIFERUS. Antunes, S. A. (New Orleans; Louisiana State University (1973). 92p. University Microfilms Order No. 743-27,820.

Thesis (Ph. D.).

Radiolysis of tryptophane was studied in shrimp Penaeus setiferus, caught off the Georgia Coast, and subjected to ionizing radiation in a cobalt-60 irradiator at Louisiana State University in Baton Rouge, La. Conditions investigated were: (1) temperature during irradiation (80, 39, and -2°F), (2) moisture content of shrimp (fresh and freeze-dried), and (3) both pasteurizing and sterilizing radiation dose levels (0.2, 1.0, and 4.5 Mrad). Special care was taken to control the factors that could affect the experimental results, such as the variations due to sampling, processing and chemical analysis. Freeze-drying the shrimp prior to radiation had no significant effect on the tryptophane-protein ratio after radiolysis. The results obtained on both fresh and freeze-dried shrimp show significant statistical differences ($p < 0.05$) due to irradiation dose levels, and to the temperature applied during radiation. However, the observed decreases in the tryptophane-protein ratios were slight: -1.55% and -1.86%, and could be considered as essentially negligible when compared with the many known advantages of preserving shrimp by ionizing radiation. Analytical data verified that the shrimp studied in this project (both irradiated and non-irradiated) were excellent sources of tryptophane, and were comparable in content of this essential amino acid to the common animal protein foods utilized in the USA such as beef, pork, and chicken. (Diss. Abstr. Int., B)

12335 MECHANICAL PROPERTIES OF RADIATION-INDUCED GRAFT-POLYETHYLENE. Sasuga, T.; Shimizu, Y.; Sasaki, T.; Tamaki, H.; Araki, K. (Japan Atomic Energy Research Inst., Takasaki). Kobunshi Kagaku; 30: No. 344, 761-766(Dec 1973). (In Japanese).

Both mechanical properties and melt-index were investigated for polyethylene grafted with vinyl chloride—vinyl acetate mixed monomer by means of pre-irradiation with electron beams from an accelerator. The empirical equations for the yield strength (YS) and the Izod-impact strength (IS) of the graft copolymer were obtained as the function of the grafting-chain fraction (F[GC]), the reacted polyethylene (F[RPE]) and the unreacted polyethylene (F[URP]): YS = 180 + 2.2 F[GC] − 0.37 F[RPE] + 0.17 F[URP] and IS = 8.0 − 0.44 F[GC] + 0.55 F[RPE] − 0.071 F[URP]. The decrease of the melt-index is mainly due to the formation of long branching of the graft chain. (auth)

12336 INDIRECT EFFECTS IN AQUEOUS SOLUTIONS OF THYMIDINE-5'-MONOPHOSPHATE IRRADIATED BY X RAYS AT 77°K. Van de Vorst, A. (Univ., Liege). Int. J. Radiat. Phys. Chem.; 6: No. 2, 143-155(Apr 1974). (In French).

It is shown that in aqueous solutions x-irradiated at 77°K: (1)

OH· radicals do not react with thymidine-5'-monophosphate (TMP) when the samples are heated from 77 to 150°K; (2) the number of OH· radicals induced in frozen aqueous solutions of TMP depends on the TMP concentration —experimental arguments are presented in favor of a sensitization of the solvent partially by the phosphate groups; (3) in a range of TMP concentration between 0.101 and 0.80 mol dm^{-3}, the indirect effects can be more than ten times as important as the direct effects; (4) from the analysis of the shape of the spectrum characterizing irradiated freeze-dried TMP, it appears that the $TH_2^{\cdot}$ radicals can be induced by a mechanism other than that involving the participation of H_2O radiolysis products. (auth)

12337 TECHNIQUES OF POLLUTION CONTROL UTILIZING RADIATION. Possibility of Purifying Sewage With Radiation Energy. Kobayashi, M. (Japan Atomic Energy Research Inst., Tokyo). Kogyo Rea Metaru; No. 51, 53-57(Feb 1973). (In Japanese).

For the control of environment pollution, various techniques utilizing radiation have been developed; some of which were already put to practical use. These methods are the proven ones currently used in many industrial fields, so they are effective. The following methods of pollution control, especially the measurement of pollution, are outlined: their principles are the absorption or scattering of radiation, x-ray fluorescence analysis, activation analysis, tracer technique, radio-release technique, etc. Utilizing radiation energy itself, it is also possible to purify sewage, though its practicability depends on economy; the oxidation of organic substances, the dissociation of organic substances, coagulation and settlement of suspended matter, the sterilization of microorganisms, etc. are achieved by the irradiation of sewage. (JA)

12338 DEFERRED ISOTHERMAL LUMINESCENCE IN ORGANIC GLASSES IRRADIATED AT 4.2 AND 77°K. Tunnelling and Thermal Detrapping. Kieffer, E.; Lapersonne-Meyer, C.; Rigaut, J. (Paris Univ., Orsay, France). Int. J. Radiat. Phys. Chem.; 6: No. 2, 79-84(Apr 1974).

At 4.2°K the isothermal luminescence (ITL) decay of both methylcyclohexane (MCH) and 3-methylpentane (3-MP) glasses containing biphenyl can be expressed by a reciprocal time law which seems to be generally observed when electron tunneling occurs. At 77°K, the same law applies only to the ITL decay of MCH glass, while that of 3-MP glass follows a reciprocal time-square law corresponding to a thermal electron detrapping mechanism. Distances of the order of 60 to 100 Å between cation and trapped electron in MCH are calculated from a formulation based on electron tunneling. (auth)

12339 SELECTIVELY PERMEABLE MEMBRANES OBTAINED BY RADIOCHEMICALLY GRAFTING PTFE FILMS. Use in Reverse Osmosis and Pervaporation. Chapiro, A. (Centre National de la Recherche Scientifique, Meudon-Bellevue, France). Rev. Gen. Caout. Plast.; 50: No. 11, 916-917(Nov 1973). (In French).

From meeting on the development of the industrial applications of radiochemistry; Paris, France (13 Mar 1973).

PTFE films having different thicknesses and structures were radiochemically grafted with several monomers. Acid (styrene, sulfone, acrylic acid), basic (4-vinyl pyridine), nonionizable (N-vinylpyrrolidone), and mixed acid basic membranes with static or localized (mosaic membranes) reagent group distributions were prepared in this way. The conditions that enabled graftings to be effected into the bulk of these films are described. Membranes prepared in this way have excellent mechanical properties when swollen and a good chemical and thermal resistance. Good results were obtained when these films were used for reverse osmosis and pervaporation. (FR)

12340 RADIOCROSSLINKING CONDITIONS FOR A FLUORINATED ELASTOMER AND THE CHANGES IN ITS RHEOLOGICAL PROPERTIES WITH IRRADIATION DOSE. Chadeyron, P.; Schmidt, Y. (Centre d'Etudes Scientifiques et Techniques d'Aquitaine, Le Barp, France). Rev. Gen. Caout. Plast.; 50: No. 11, 921-926(Nov 1973). (In French).

From meeting on the development of the industrial applications of radiochemistry; Paris, France (13 Mar 1973).

The initial polymer, voltalef 3700, is briefly described. The preparation of mixtures is then discussed together with the irradiation conditions. The techniques used to study the characteristics of the irradiated polymer are then described: swelling in a solvent; rheological tests (stress relaxation and dynamic tensile stress measurements). Results were obtained on the part played by the cross-linking agent (comparative studies of some polyallylic compounds enabling the most important properties of radiocrosslinkable systems to be established), and also, on the changes occurring in the rheological properties of a particular radiocrosslinkable system as a function of the radiation dose, comparisons between dynamic and static tests being effected. (FR)

12341 REACTOR RADIOLYSIS OF SUCCINIC ACID. Bartonicek, B. (Ustav Jaderneho Vyzkumu, Rez, Czech.). Int. J. Radiat. Phys. Chem.; 6: No. 2, 71-77(Apr 1974).

The radiolysis of solid succinic acid in a nuclear reactor was examined. Carbon dioxide, succinic semialdehyde, propionic acid, and water are the main products of the decomposition. Carbon monoxide, hydrogen, methane, and acetic, formic, and adipic acids are formed with smaller yields; the presence of hydroxy acids and of a polymer among the decomposition products was also proved. On the basis of the yields of the products, a mechanism for the radiolysis of solid succinic acid with reactor radiation is proposed. (auth)

12342 CLEAVAGE OF TRITIUM FROM SOLID, GAMMA-IRRADIATED CYTOSINE-5-T. Merwitz, O. (Kernforschungsanlage, Juelich, Ger.). Radiat. Environ. Biophys.; 11: No. 1, 63-68(Mar 1974). (In German).

The dose-effect curve for the cleavage of tritium from γ-irradiated cytosine-5-T was measured and compared with dose-effect curves for other specifically labeled nucleic acid bases. The graphically determined threshold dose for the cleavage of tritium from cytosine-5-T is of the order of 2×10^4 rad. The radiation-induced radicals in cytosine are discussed. (GE)

12343 MOESSBAUER SPECTROSCOPY OF HEMIN AND METHEMOGLOBIN EXPOSED TO IONIZING RADIATION. Rymarchuk, V. I.; Stukan, R. A.; Libinzon, R. E.; Prussakov, V. E.; Moshkovskii, Yu. Sh.; Gol'denskii, V. I. Dokl. Akad. Nauk SSSR; 213: No. 1, 228-230(1973). (In Russian).

The electron state of Fe in irradiated crystalline samples of hemin and hemoglobin was studied. The effect of ionizing radiation on the Moessbauer spectra of these compounds was determined. An analysis was made of the Moessbauer spectrum of dry hemin powder, γ-irradiated (^{60}Co with a dose of 10 Mrad) hemin after defrosting, and hemin exposed to the effects of uv radiation. The magnitudes of the isomeric displacements and the quadrupole splitting were indicated by the hemin spectra. The Moessbauer spectra of dry methemoglobin, methemoglobin irradiated with ^{60}Co γ-rays at a dose of 10 Mrad and at a temperature of liquid nitrogen, and defrosted irradiated methemoglobin. An analysis was made of the significant changes. (tr-auth)

12344 EFFECTS OF GAMMA RADIATION ON THE SOLUBILITY AND MECHANICAL PROPERTIES OF BUTADIENE–SYRENE BLOCK COPOLYMERS. Tutorskii, I. A.; Shatalov, V. P.; Kondrat'ev, A. N.; Finkel, E. E. (Scientific-Research Inst. of Synthetic Rubber, Moscow). Kauchuk Rezina; No. 11, 21-23 (1973). (In Russian).

The effects of doses for 0 to 800 Mrad units of gamma radiation were observed in polystyrene-polybutadiene block copolymers containing 30, 50, and 85% styrene. It was found that the solubility in benzene and the viscosity of polystyrene are unaffected by the radiation at these levels, while solubilities of the block copolymers decrease with increasing doses of radiation, and viscosities show a slight decrease, then increase. The dose of gamma radiation at which gelation begins rises as the amount of styrene increases, relative elongation of the block-copolymers decreases as dosage increases, while shear strength at 50% elongation increases. The fact that polybutadiene both in the homopolymer and the copolymer undergoes radiation-induced cross-linking, while polystyrene does not is used to explain these effects. It was also found that G values are independent of the amount of styrene in the copolymer, indicating that styrene does not protect polybutadiene from radiation effects. (JPRS)

12345 PULSE RADIOLYSIS OF ORGANIC HALOGEN COMPOUNDS. Reaction Mechanism, Dose Rate Effects, and Product Back Reactions in Pure Bromobenzene. Buehler, R. E.; Bossy, J. M. (Eidgenoessische Technische Hochschule, Zurich). Int. J. Radiat. Phys. Chem.; 6: No. 2, 95-116(Apr 1974).

The radiolysis of bromobenzene (BrPh) was studied by product analysis from single-pulse, multi-pulse, and continuous irradiations with dose rates differing by a factor of 10^{11}. The primary aim was to determine the reaction mechanism in which the bromine atom charge transfer complex (Br·BrPh) is taking part. Together with results from kinetic spectroscopy [Bossy et al., Int. J. Radiat. Phys. Chem. 6:85 (1974)] a reaction mechanism for the single-pulse irradiation of bromobenzene is proposed, which is supported by a material balance in all irradiations. The dose rate effect found is explained by first- to second-order competition kinetics and by the differences in the primary ionic and/or radical recombinations in the early stages of radiolysis. For multi-pulse or continuous irradiations the products interfere with the reaction scheme through quenching and through one or more radical back-reactions. (auth)

12346 PULSE RADIOLYSIS OF ORGANIC HALOGEN COMPOUNDS. Transients in Pure Bromobenzene. Bossy, J. M.; Buehler, R. E. (Eidgenoessische Technische Hochschule, Zurich). Int. J. Radiat. Phys. Chem.; 6: No. 2, 85-94(Apr 1974).

Results from the pulse radiolysis of bromobenzene are presented and discussed. The primary aim was to determine the kinetics of the bromine atom charge transfer complex with bromobenzene and its importance in the general reaction mechanism. From the transient absorption (λ_{max} = 560 nm), due to the $Br{\cdot}BrC_6H_5$ complex, the rate constant for its unimolecular decay was determined to be $(5.4 \pm 0.2) \times 10^4$ s^{-1}. From the competition with triphenylmethane (TPMH) the extinction coefficient $\epsilon_{350} = 26{,}000 \pm 6{,}000$ dm^3 mol^{-1} and $G(Br{\cdot}BrC_6H_5) = 1.8 \pm 0.4$ was derived. The 350 nm transient absorption is tentatively assigned to the dibromo- and phenyl-bromocyclohexadienyl radicals. Reactions are proposed which, by a computer analysis, can reproduce the pulse-dose dependence of the apparent first-order rate constant for the $(Br{\cdot}BrPh)$ complex decay and hence enable the rate constants of most reactions to be derived. (auth)

12347 CHEMICAL-COMPOSITION DISTRIBUTION OF STYRENE–ACRYLONITRILE COPOLYMER SYNTHESIZED BY RADIATION-INDUCED COPOLYMERIZATION AT LOW TEMPERATURE. Teramachi, S.; Uchiyama, H. (Nagoya Univ., Japan). Polym. J.; 5: No. 3, 243-247(Jan 1974).

A styrene–acrylonitrile copolymer was synthesized by radiation-induced copolymerization in ethyl bromide at -78°C. The chemical-composition distribution curve of the sample obtained from the results of compositional fractionation is not continuous, but shows two distinctly different peaks. The acrylonitrile contents of the two peaks are close to those of copolymers polymerized by anionic and free-radical mechanisms, respectively. From this result, it becomes clear that the copolymer sample is a mixture of two kinds of copolymers polymerized by both mechanisms, and it is also clear that both anionic and free-radical mechanisms coexist in this copolymerization process. Moreover, it is shown that the copolymer may have a chemical composition corresponding to an anionic mechanism only if the reaction mixture is highly dried under vacuum. (auth)

12348 ESR STUDIES ON PRIMARY PROCESSES IN RADIATION-INDUCED REACTIONS. VI. Isoprene and 1,3-PENTADIENE IN ALKYL HALIDE MATRICES. Shiga, T.; Okamura, S. (Kyoto Univ.). Polym. J.; 6: No. 1, 7-11(Mar 1974).

The cation radical of isoprene was first detected by means of ESR. It was produced by γ-irradiation in carbon tetrachloride, and has proton coupling constants of a_1 = 13.0 G (2H), a_2 = 4.9 G (3H), a_3 = 3.2 G (1H), and a_4 = 9.2 G (2H). In n-butyl chloride glass at 77°K a linear allyl-type radical was formed from isoprene. The initiation of polymerization by the isoprene cation radical was suggested in n-butyl chloride glass at 77°K during γ-irradiation. A cyclohexadienyl-type radical was produced from trans-1,3-pentadiene by γ-irradiation in carbon tetrachloride, whereas a linear allyl-type radical was produced from cis-1,3-pentadiene. In a n-butyl chloride glass, a linear allyl-type radical was produced from both 1,3-pentadiene by γ-irradiation at 77°K. The cation radical were suggested to initiate radiation-induced polymerization in n-butyl chloride glass at 77°K. (auth)

12349 ULTRACENTRIFUGE STUDIES OF MOLECULAR WEIGHT DISTRIBUTIONS IN γ-IRRADIATED POLYSTYRENE. Kells, D. I. C. Toronto; Univ. of Toronto (1972). National Library of Canada, Ottawa.

Thesis (Ph. D.).

The molecular weight distribution of a narrow distribution sample of polystyrene was measured using the ultracentrifuge sedimentation velocity technique. Correction procedures for the zero sedimentation time error, pressure, diffusion and concentration were investigated and all had to be applied to obtain reasonable estimates of the molecular weight distribution. (LK)

12350 RADIATION-INDUCED DEBROMINATION OF SYM-DIBROMOTETRAFLUOROETHANE. Effect of Fluorine Atoms on the Stability of Monobromo Substituted Ethyl Radicals. Ben-Yehuda, M.; Katz, M. G.; Rajbenbach, L. A. (Israel Atomic Energy Commission, Yawne). J. Chem. Soc., Faraday Trans., I; 70: No. 5, 908-916(1974).

The kinetics of the γ-radiation-induced free-radical chain reactions in solutions of sym-$C_2F_4Br_2$ in cyclohexane (RH) were studied in the temperature range 150 to 250°C. Bromotetrafluoroethyl radicals were produced by reaction of radiolytically generated cyclohexyl radicals with sym-$C_2F_4Br_2$. The kinetics of the following reactions were investigated: $C_2F_4Br + RH \rightarrow C_2F_4BrH + R$ and $C_2F_4Br \rightarrow C_2F_4 + Br$. The following rate expression is obtained: $\log_{10}[(k_4/k_5)/\text{mol dm}^{-3}] = 7.86 \pm 0.13 - [(54{,}600 \pm 1260)\ J\ mol^{-1}/2.3\ RT]$. From the activation parameter of the rate expression and the assumptions that $E_3 = E(C_2F_5 + RH)$ and $D(CF_2BrCF_2{-}Br) = D(C_2F_5{-}Br)$ then $E_4 = 81.50 \pm 2.85$ and $E_{-4} = 8.7$ kJ mol^{-1}. Arguments based on bond energy terms are presented to show that fluorine substitution affects the C-C bond energy in normal alkanes and that the difference in activation energy in bromine atom elimination reactions from C_2F_4Br and C_2H_4Br radicals cannot be correlated with the π bond destabilization effect of fluorine atoms in C_2F_4 as measured by the difference in enthalpies of polymerization of C_2F_4 and C_2H_4. It is also suggested that in the case of C_2F_4Br, fluorine atoms affect the stability at the radical center. (auth)

12351 IRRADIATION OF POLYMETHYLMETHACRYLATE. In-Vitro Gamma Radiation Effect. Murray, J. A.; Bruels, M. C.; Lindberg, R. D. (Texas Univ., Houston). J. Bone Joint Surg.; 56A: No. 2, 311-312(Mar 1974).

Data resulting from γ radiation of polymethylmethacrylate indicate that the clinical use of ^{60}Co irradiation of neoplastic disease in bone is not affected by the presence of polymethylmethacrylate, nor is the polymethylmethacrylate affected at the level of γ radiation in clinical use today. (auth)

12352 TELOMERIZATION OF ETHYLENE AND ALIPHATIC ALCOHOLS INDUCED BY GAMMA RAYS. van Wyk, L.; Basson, R. A. (Atomic Energy Board, Pretoria). 70: No. 5, 839-846 (1974).

The radiolysis products of ethylene in methanol, propan-1-ol, propan-2-ol, butan-2-ol, 2-methylpropan-2-ol, and 2-methylpropan-1-ol were determined. The present results are in agreement with polymerization studies in so far that the transfer efficiency of the various alcohols varies remarkably. From these results, it is shown that the yield of telomers is proportional to the transfer efficiency of the alcohols. (auth)

12353 THEORY OF EPR SPECTRA OF FREE RADICALS. pp 11-78 of EPR Svobodnykh Radikalov v Radiatsionnoi Khimii. Pshezhetskii, S. Ya. (ed.). Moscow; Khimiya (1972). (In Russian).

Results are presented on studies of free radicals in irradiated materials by EPR spectroscopy such as: inorganic hydrocarbons, organic compounds having functional groups, and high-molecular-weight compounds. The principles of the theory of EPR spectra of free radicals are given. Particular attention is devoted to identification of radicals from EPR spectra. The theoretical principles of the EPR spectroscopy of free radicals make it possible from the characteristics of EPR spectra to determine the composition and structure of radicals, the conformation, the reaction and other conversions of radicals. An analysis of the superfine structure of the EPR spectrum gives the most complete information on the radicals. (SJR)

12354 PULSE RADIOLYSIS OF THE AQUEOUS FERRO-FERRICYANIDE SYSTEM. II. Reactions of Hydrogen Atoms and e^-_{aq} With Ferrocyanide and Ferricyanide Ions. Zehavi, D.; Rabani, J. (Hebrew University, Jerusalem). J. Phys. Chem.; 78: No. 14, 1368-1373(4 Jul 1974).

Hydrogen atoms react with both ferro- and ferricyanide. The reaction with ferrocyanide, previously unknown, proceeds with a rate constant $k(H + Fe(CN)_6^{4-}) = 4 \times 10^7$ M^{-1} sec^{-1}, independent of pH in the range 1 to 8. This reaction is followed by two consecutive processes, of which the first one is first order, while the second one is a reaction of an intermediate with ferrocyanide ions. Aquapentacyanoferrate(II) was identified as a final product. All the intermediates reacted with ferricyanide. The nature of the reaction products is discussed and the rates of the various processes measured as a function of pH are given. Hydrated electrons react only slowly, if at all, with ferrocyanide ions, $k(e^-_{aq} + Fe(CN)_6^{4-}) < 7.5 \times 10^4$ M^{-1} sec^{-1}. Low yields of aquapentacyanoferrate(II) (~10%) are produced by reduction of ferricyanide ions by H atoms and e^-_{aq} at neutral pH. (auth)

12355 CHANGES IN THE SURFACE PROPERTIES OF FLUOROLONES BY METHACRYLIC ACID RADIATION GRAFTING. Kochnev, I. G.; Kulikov, E. T.; Perovskii, A. P. Plast. Massy; No. 8, 12-13(1973). (In Russian).

The modification of the surface properties of fluorolones by radiation grafting in the gaseous phase in a nitrogen atmosphere on the surface of methacrylic acid polymers in order to increase the density of the negative surface charge was described. It was established that the electrokinetic potential and the charge density of the surface is increased by grafting with methacrylic acid. (tr-auth)

12356 RADIOLYTIC OXIDATION OF ANTIMONY(III) IN H_2SO_4 AND HCl IN ABSENCE AND PRESENCE OF NONPOLAR LIQUIDS. Allan, A.; Haggag, A. (Atomic Energy Establishment, Inshas, Egypt). J. Inorg. Nucl. Chem.; 36: No. 3, 679-682(Mar 1974).

It was observed by Matsuura et al. (Sci. Papers Inst. Phys. Chem. Res.; 55:224(1961)) that antimony (III) in 0.8 N H_2SO_4 and 0.8 N HCl is oxidized to the pentavalent state by the gamma radiation of Co-60 in an air-saturated solution. Although the radiation yield for the production of antimony (V), $G(Sb^{+5})$, calculated by them (~3 ions per 100 eV) is lower than the values that satisfy an ideal chemical dosimeter, it seemed quite interesting to study the factors affecting ($G(Sb^{+5})$). In addition to factors such as irradiation dose, antimony concentration and ageing of the solution, the influence of nonpolar liquids on the radiation oxidation of antimony (III) ions in sulfuric and hydrochloric acid solutions was studied. Benzene, toluene, xylene, chloroform, and carbon tetrachloride were selected as commonly available nonpolar diluents. Results are presented, and reaction mechanisms discussed. (UK)

12357 GAMMA IRRADIATION EFFECT ON THE SULFHYDRYLS CONTENT OF SKIMMILK POWDER. Hsu, H.; Hadziyev, D.; Wood, F. W. (Univ. of Alberta, Edmonton). Can. Inst. Food Technol. J.; 5: No. 4, 191-196(Oct 1972).

The effect of gamma-irradiation of skimmilk powder on the sulfur-containing constituents that may contribute to flavor defects when the powder is recombined with water was investigated. Before irradiation no free-SH groups were detected in the laboratory prepared powders but they were present (18.5 mM/100g) in the commercial high heat powder studied. After the application of irradiation doses of 0.4, 0.8, 1.2 and 1.6 Mrads the percentage increase in the -SH groups of the laboratory produced powder was 15.3 to 69.2 for free, 6.4 to 9.3 for masked, and 6.4 to 29.3 for total sulfhydryl groups. The corresponding results for the commercial powder were 2 to 20 for free, 7.3 to 9.4 for masked, and 12.8 to 32.3 for total -SH groups. The addition of ascorbic acid to the liquid skimmilk, which, after drying, amounted to 2.7 to 23.8 mM/100 of powder was reflected in a 2.4 to 16.5% decrease in total -SH groups when an irradiation dose of 0.4 Mrads was applied. Ascorbyl palmitate added under the same conditions and concentrations decreased the total -SH groups by 3.5 to 29.9%. Similar protection of the powder was obtained when the irradiation dose was 1.6 Mrads. The irradiation of skimmilk powder containing labelled $^{14}C_1$-ascorbic acid revealed degradation products which could be recovered as carbonyls. (auth)

12358 GAMMA IRRADIATION EFFECT ON SOME VOLATILES OF SKIMMILK POWDER. Hsu, H.; Hadziyev, D.; Wood, F. W. (Univ. of Alberta, Edmonton). Can. Inst. Food Sci. Technol. J.; 5: No. 4, 197-202(Oct 1972).

The effect of gamma-irradiation on the off-flavor development in skimmilk powders was studied by analysis of the sulfur and non-sulfur containing volatiles of the powders using a column flush gas liquid cochromatography technique. Sulfur-containing volatiles found in irradiated commercial skimmilk powder were methyl-, ethyl-, n-butyl-, sec-butyl- and allyl-mercaptans and ethyl methyl- and diallyl sulfides. Ethyl mercaptan, n-propyl- and allyl-mercaptans were not found in non-irradiated samples and the other compounds were present only in trace amounts. The volatiles not containing sulfur were separated and identified to be aldehydes, ketones, and lower members of alkanoic acid, thus supporting the assumption that the residual amounts of 0.06% of lipid in skimmilk powder also contributed to the development of off-flavors in irradiated milk powder. (auth)

12359 PRODUCTION OF NEGATIVE IONS FROM CH_3X MOLECULES (CH_3NO_2, CH_3CN, CH_3I, CH_3Br) BY ELECTRON IMPACT AND BY COLLISIONS WITH ATOMS IN EXCITED RYDBERG STATES. Stockdale, J.A.; Davis, F.J.; Compton, R.N.; Klots, C.E. (Health Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). J. Chem. Phys. 60: No. 11, 4279-4285 (1 June 1974).

Thermal electron attachment to nitromethane, methylcyanide, methyliodide, and methylbromide is compared with capture of electrons by these molecules from highly excited Rydberg states of atoms. Data on thermal electron attachment to CH_3NO_2 are consistent with a three-body attachment process, with the nature of the third body being important. The thermal energy electron attachment rate constant for CH_3CN is $\lesssim 1.24\times10^{-14}$ cm^3 sec^{-1}. Some results on dissociative electron attachment and ion pairing processes in CH_3NO_2, CH_3CN, CH_3I, and CH_3Br are also presented. (auth)

12360 EFFECT OF AN EXTERNAL ELECTRIC FIELD ON THE YIELD OF FREE IONS. II. THE INITIAL DISTRIBUTION OF ION PAIRS IN LIQUID HYDROCARBONS. Mozumder, A. (Department of Chemistry and the Radiation Laboratory, University of Notre Dame, Notre Dame, Indiana 46556). J. Chem. Phys. 60: No. 11, 4305-4310 (1 June 1974).

In this paper initial-distribution-averaged escape probability has been calculated for a variety of compounds using the procedure developed in the preceding paper. The present method allows computation at any external field strength and temperature although the possible effect of very high external fields on the initial distribution of the ion pairs has been ignored. It has been found that no unique form of distribution function is the "best" under all circumstances even though in many cases an exponential or a Gaussian form suffices. An extended initial distribution function tends to reduce the "temperature inversion effect," i.e., the decrease of escape probability with temperature at high fields. Nevertheless at suitably high fields the escape probability averaged over several distribution functions is predicted to be relatively insensitive to temperature over a wide range; such an effect should be observable. (auth)

12361 EFFECT OF AN EXTERNAL ELECTRIC FIELD ON THE YIELD OF FREE IONS. I. GENERAL RESULTS FROM THE ONSAGER THEORY. Mozumder, A. (Department of Chemistry and the Radiation Laboratory, University of Notre Dame, Notre Dame, Indiana 46556). J. Chem. Phys. 60: No. 11, 4300-4304 (1 June 1974).

Onsager's equation for the effect of an external electric field on the probability of an isolated ion pair escaping neutralization in a dielectric medium has been rearranged for evaluation in a consistent way. The present treatment allows the escape probability to be written as a single series valid for arbitrary field strengths and initial separations. In a given case, procedure is outlined for calculating this probability in the most systematic manner. Although expansion of the escape probability in powers of the external field is not advisable at high field strengths because of the slowness of convergence, the field coefficients are provided for evaluation and comparison at relatively low fields. At high fields possibility of a temperature inversion effect is indicated; that is, the field-dependent escape probability may actually decrease with temperature. (auth)

12362 LOW-ENERGY (<1 eV) ELECTRON ATTACHMENT TO MOLECULES IN VERY-HIGH PRESSURE GASES: C_6H_6. Christophorou, L.G.; Goans, R.E. (Health Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). J. Chem. Phys. 60: No. 11, 4244-4250 (1 June 1974).

Benzene has been found to capture slow ($\lesssim 0.3$ eV) electrons in high densities of N_2 (and Ar) with a rate that increases with increasing N_2 density and decreasing electron energy at near-thermal energies. The dependence of the attachment rate on the N_2 density and the electron energy has been studied in detail, and a model is presented that accounts for the experimental results. On the basis of this model the autodetachment lifetime of $C_6H_6^{-*}$ has been estimated and found to vary from ~1 psec at 0.04 eV to ~0.2 psec at 0.18 eV. From the high-pressure experiments the "liquid state behavior" has been predicted also. The finding that benzene negative ions are formed in the gas phase forces the conclusion that the benzene molecule has a positive (>0 eV) electron affinity, $(EA)_a$, contrary to the accepted view that $(EA)_a<0$ eV. The short autodetachment lifetime of $C_6H_6^{-*}$, however, indicates that $(EA)_a$ is small. Benzene was also studied in mixtures with C_2H_4 and C_2H_4-N_2. The results of these latter experiments strongly indicated that the probability of electron detachment in $C_6H_6^{-*}$-C_2H_4 collisions is large. (auth)

12363 IONIZATION IN LIQUID HYDROCARBONS: γ RADIOLYSIS YIELDS AND ELECTRON RANGE DISTRIBUTION FUNCTIONS. Dodelet, J.; Freeman, G.R. (Chemistry Department, University of Alberta, Edmonton, Canada T6G 2G2). J. Chem. Phys. 60: No. 12, 4657-4659 (15 June 1974).

The use of an exponential distribution of initial separation distances in thermalized electron-ion pairs in γ irradiated liquid hydrocarbons leads to the calculation of total ionization yields of $G_{ion} \approx 5$-6. The distribution possesses a power function tail (y^{-3}) at large initial separations (y). The concepts of ionization and excitation in a liquid are briefly dicussed. (auth)

12364 MECHANISMS OF x-RAY-INDUCED EXCITATION. EFFECT OF SCAVENGERS ON THE RADIOLUMINESCENCE OF GLASSY SOLUTIONS. Steen, H.B.; Strand, O. (Norsk Hydro's Institute for Cancer Research, Department of Biophysics, The Norwegian Radium Hospital, Montebello, Oslo 3, Norway). J. Chem. Phys. 60: No. 12, 5043-5049 (15 June 1974).

The luminescence of indole and tryptophan in EG/H_2O glass at 77 K during irradiation with x rays and uv light has been studied with various concentrations of two electron scavengers (acrylamide and trichloroacetate). The two types of radiation gave identical emission spectra except for a considerable enhancement of the phosphorescence to fluorescence ratio with x irradiation. The effect of the scavengers on the yields of x-ray-induced singlet (S) and triplet (T) levels were calculated from the results. It was found that the yield versus scavenger concentration curves could be decomposed into two components, one being independent of the scavenger, the other one decreasing exponentially with increasing scavenger concentration. Associating the former component with excitation directly from the ground state and the latter with excitation resulting from recombination between solute cations and electrons, it was found that about 80% of the solute

excitation is due to recombination. In the case of indole the ratio of triplets to singlets T/S formed by direct excitation was T/S=0.2, whereas for the recombination T/S=1.2. The latter value was attributed primarily to spin relaxation of the recombining ion pairs, whereas intersystem crossing between highly excited levels and recombination in spurs appeared to be of minor importance in this respect. The spin relaxation of the recombining ions, the large scavenger concentrations needed to quench recombination, and the observation that T/S was independent of the LET of the radiation indicated that the recombining ions are closely associated so that the ion pair may be comparable to the CTTS states involved in photoionization of solutes rather than to pairs of free separate ions. (auth)

12365 PROTON TRANSFER IN IRRADIATED L-CYSTEIC ACID MONOHYDRATE. Box, H. C.; Budzinski, E. E. (Roswell Park Memorial Inst., Buffalo). J. Chem. Phys.; 60: No. 8, 3337-3338(15 Apr 1974).

The protonation of the reduced species in x-irradiated single crystals of cysteic acid monohydrate was observed by ESR and ENDOR spectroscopy. (LK)

12366 CHEMICALLY INDUCED DYNAMIC ELECTRON POLARIZATION. V. Possible Theory for Alkyl Radicals Produced in Radiolyses. Wong, S. K.; Hutchinson, D. A.; Wan, J. K. S. (Queen's Univ., Kingston, Ont.). J. Chem. Phys.; 60: No. 8, 2987-2990(15 Apr 1974).

The spontaneous emission and enhanced absorption pattern of the initial spin polarization of alkyl radicals, XH_2 and XH_3, produced in radiolyses are described. It is assumed that the various total spin multiplets (electron and nuclear) have different probabilities of formation; this is an extension of our earlier work on the H and D atoms. The mode—spontaneous emission or enhanced absorption—for a given ESR line depends on two factors: first, which total spin multiplet is the more probable and second the sign of the isotropic hyperfine splitting constant. (auth)

12367 ELECTRON PARAMAGNETIC RESONANCE STUDY OF RADIATION DAMAGE IN SIMPLE AMINO ACIDS. Close, D. M. Worcester, MA; Clark Univ. (1973). 207p. University Microfilms Order No. 74-9219.

Thesis (Ph. D.).

A study of free radicals trapped in irradiated single crystals of amino acids was made by the technique of electron paramagnetic resonance (EPR). Other workers have shown that the EPR spectra of irradiated amino acids are often complicated by overlapping signals from several distinct paramagnetic species. Therefore a study was made of resolution enhancement techniques including uv photobleaching, isotopic substitution, ENDOR, controlled warming and aging. Ultraviolet photobleaching proved useful in removing one unstable paramagnetic species in γ-irradiated dithreonine, allowing the identification of the stable $CH_3\dot{C}(OH)CH(N^+H_3)CO_2^-$ radical. A controlled warming experiment lead to the tentative identification of the $N^+H_3CH_2\dot{C}HCO_2^-$ radical in the room temperature EPR spectrum of γ-irradiated β-alanine. The techniques of aging and warming were used on a variety of other irradiated amino acids in an attempt to learn about the stability of radicals trapped in single crystals. (Diss. Abstr. Int., B)

12368 STUDY OF THE RADIATION INDUCED EXCHANGE OF OXYGEN-18 IN INORGANIC MOLECULAR IONS. Holtzscheiter, E. W. Jr. College Park, MD; Univ. of Maryland (1973). 150p. University Microfilms Order No. 74-9797.

Thesis (Ph. D.).

An oxygen exchange reaction was observed during the radiation-induced decomposition of inorganic organions when these salts are irradiated in an atmosphere of oxygen-18. This reaction or series of reactions is capable of enriching nitrates, chlorates, bromates, and iodates in oxygen-18 by simply irradiating the compounds in the presence of oxygen-18 gas. An important aspect of this research has been the revelation that the various mechanisms postulated for the radiation-induced decomposition of these salts are inadequate and considerably more research must be done before reasonable mechanisms, consistent with experimental data, can be developed. Cesium, potassium, barium, and sodium nitrate were irradiated in the presence of oxygen-18 gas. Low percentage oxygen-18 enrichment (3 to 5%) was observed via Raman spectroscopy. The observed oxygen-18 distribution was consistent with the previously postulated nitrite precursor: $N^{18}O_2^- \rightsquigarrow N^{18}O_2^- + {}^{18}O$, $N^{18}O_2^- + {}^{18}O_2 \rightsquigarrow N^{18}O_2{}^{18}O^- + {}^{18}O$. The oxygen exchange reaction was further found to be sensitive to particle size effects and to show a correlation between oxygen-18 incorporation and crystal "free space." The study of $KBrO_3$ indicated that the bromates could also be enriched by the irradiation of $KBrO_3$ in the presence of oxygen-18 gas (overall enrichments of ~3 atom percent). The oxygen exchange reaction observed via Raman spectroscopy indicated the formation of $KBr^{18}O^{18}O_2^-$ only. An overall reaction consistent with these results was postulated: $Br^{18}O_3^- \rightsquigarrow Br^{18}O^- + {}^{18}O_2$, $Br^{18}O^- + {}^{18}O_2 \rightsquigarrow Br^{18}O^{18}O_2^-$. In addition to the observed oxygen exchange, the Raman spectrum of O-18-enriched $KBrO_3$ was recorded and the symmetric stretching vibrations identified. The investigation of $KClO_3$, $KClO_3$, and $KClO_4$ indicated that oxygen exchange takes place only in the chlorate system. The observed O-18 enrichment was approximately 3 atom percent. A series of experiments varying temperature and additives indicated that ClO_2 was the most likely precursor to the production of $Cl^{18}O_2{}^{18}O^-$, the primary enrichment product. Although previous studies have indicated the iodates to be very stable to gamma irradiation, an oxygen exchange reaction capable of producing KIO_3 enriched in O-18 to 2.5 atom percent was observed. KIO_4 indicated only the formation of enriched KIO_3 via irradiation in the presence of O-18 (i.e., no O-18 enriched KIO_4 was observed). A series of experiments indicated I^- to be the most probable precursor to the oxygen exchange reaction; however, a mechanism for this reaction was not evident from the results. In addition to the nitrates and the halates, $KMnO_4$, K_2SO_4, and K_2CO_3 were also irradiated in the presence of O-18 gas. There was no observed O-18 enrichment in $KMnO_4$ and K_2SO_4; however, K_2CO_3 did show signs of slight O-18 enrichment. Thus, the oxygen exchange reaction may be extended to other oxyanions as a potential method of oxygen isotope enrichment. (Diss. Abstr. Int., B)

12369 DECAY KINETICS OF SORBED METHYL RADICALS GENERATED BY PHOTODECOMPOSITION AND RADIOLYSIS OF METHYL HALIDES ON SILICA GEL. Joppien, G. R.; Willard, J. E. (Univ. of Wisconsin, Madison). J. Phys. Chem.; 78: No. 14, 1391-1394(4 Jul 1974).

The decay kinetics of adsorbed CH_3 radicals produced by γ-irradiation at 77°K of silica gel containing adsorbed methyl halides indicate the presence of several types of trapping sites. The decay rates are all first order with respect to the initial concentration and the predominant decay processes have activation energies of 3 to 6 kcal/mol. The relative yields of the more rapidly decaying populations decrease with increase in the temperature (25, 460, and 600°) at which the gel is evacuated prior to irradiation at 77°K. The nature of this decrease suggests correlation with the changing ratio of geminal to vicinal to isolated hydroxyl groups on the surface. γ-Irradiation at 300°K of silica gel containing CH_3I produced no observed CH_3 but photolysis of the sorbed CH_3I at either 300 or 77°K yielded stable radicals. (auth)

12370 RECOMBINATION AND OTHER REACTIONS OF STABILIZED RADICALS. pp 326-372 of EPR Svobodnykh Radikalov v Radiatsionnoi Khimii. Pshezhetskii, S. Ya. (ed.). Moscow; Khimiya (1972). (In Russian).

Results are presented on EPR studies of free radicals in irradiated substances. The kinetics and mechanism of radical destruction at higher temperatures are considered. The stability and recombination temperature of stabilized radicals depends strongly on the physical properties of the matrix, and also on the features of radical structure. A dependence was obtained for the relative concentration of radicals as a function of temperature. Data are given on effective values of the activation energy and rate constants for radical recombination in various substances. Radical destruction during irradiation takes place not as a result of the direct action of radiation but as a result of various processes taking place in the matrix under irradiation. Consideration is given to the reactions of hydrogen atoms with molecules in the solid phase, as a result of which a significant number of free radicals are formed. Radical conversion in the presence of oxygen is considered. The role of radicals in radiation polymerization and grafting is explained. (SJR)

12371 EPR SPECTRA AND RADICAL FORMATION ON IRRADIATION OF HIGH-MOLECULAR COMPOUNDS. pp 282-235 of EPR Svobodnykh Radikalov v Radiatsionnoi Khimii. Pshezhetskii, S. Ya. (ed.). Moscow; Khimiya (1972). (In Russian).

Experimental data are presented on radicals formed during irradiation of polymeric hydrocarbons, fluorine- and chlorine-containing polymers, and natural polymers (proteins, amino acids). The EPR method makes it possible to study the nature, structure and properties of the radical, and to establish its role in the mechanism of changes in polymer properties under irradiation. Features of the EPR spectra of macroradicals are noted. Kinetic studies of radical accumulation during irradiation of various, high-molecular substances showed that destruction of radicals took place along with the formation of radicals. The radicals were destroyed not as a result of the direct action of radiation, but as a result of the transmission of energy to the radicals that was adsorbed by the polymer molecule. The effect of temperature on the accumulation of radicals in various phase states of polymers is different. The yield of free radicals depends on the chemical structure of the polymers. A study was made of

the effect of impurities (electron acceptors) on the radiation yield of radicals. (SJR)

Radiochemistry and Nuclear Chemistry

Refer also to abstract 13279.

Hot-Atom Chemistry

12372 (BNL-18899) APPLIED HOT-ATOM CHEMISTRY, LABELING OF COMPOUNDS, ISOTOPE PRODUCTION. Wolf, A. P. (Brookhaven National Lab., Upton, N. Y. (USA)). [nd]. 8p. (CONF-740540-2). Dep. NTIS $4.00.

From panel on the theory of hot atom chemistry; Vienna, Austria (13 May 1974).

Hot-atom chemistry had its initial and most direct impact in developing radiopharmaceuticals labeled with ^{11}C, ^{13}N, ^{15}O, ^{18}F, and ^{123}I. Nuclide production, precursor preparation, labeling methods, and analytical control are discussed. (MCG)

12373 (BNL-18900) POSITION PAPER ON HOT-ATOM CHEMISTRY IN INORGANIC SOLIDS. Harbottle, G. (Brookhaven National Lab., Upton, N. Y. (USA)). 1974. 10p. (CONF-740540-3). Dep. NTIS $4.00.

From panel on the theory of hot atom chemistry; Vienna, Austria (13 May 1974).

The present status of research in solid-state hot atom chemistry is discussed, with emphasis on theory. Reactions of ^{51}Cr atoms in K_2CrO_4 crystals are considered as examples. (12 references) (MCG)

12374 (BNL-18901) HOT-ATOM CHEMISTRY OF CARBON. Wolf, A. P. (Brookhaven National Lab., Upton, N. Y. (USA)). 1974. 12p. (CONF-740540-4). Dep. NTIS $4.00.

From panel on the theory of hot atom chemistry; Vienna, Austria (13 May 1974).

The chemistry of energetic carbon atoms discussed draws its hypothesis from reactions studied in saturated systems. The electronic state of the atom in its first reactive encounter is considered. It is postulated that the hot carbon atom (^3P and ^1D) can insert into a carbon–hydrogen bond and that it can also abstract hydrogen. (MCG)

12375 (BNL-18902-R) IMPACT OF THEORETICAL CHEMISTRY ON ELUCIDATION OF HOT ATOM REACTION MECHANISMS. (Brookhaven National Lab., Upton, N. Y. (USA)). 1974. 14p. (CONF-740540-1). Dep. NTIS $4.00.

From panel on the theory of hot atom chemistry; Vienna, Austria (13 May 1974).

A result of much recent theoretical work is that complete excitation functions based on extensive classical trajectory calculations and realistic potential energy surfaces are now available. Work on potential energy surfaces is also discussed. The reactivity of atomic carbon is considered along with its relevance to recoil reactions. (MCG)

12376 ENERGY DEPENDENCE OF THE REACTIONS OF ATOMIC TRITIUM WITH 1-CHLOROBUTANE. Durana, S. (Department of Chemistry, University of Illinois, Urbana, Illinois 61801); LeRoy, R.L.; Menzinger, M.; Yencha, A.J. J. Chem. Phys. 60: No. 6, 2568-2569 (15 Mar 1974).

Energy dependence of the reactions of atomic tritium with 1-chlorobutane is reported. A neutralized tritium ion beam was used in the experiment. Yields obtained for the reactions of neutral tritium atoms with condensed 1-chlorobutane are given. (AIP)

12377 ABSENCE OF A LOW ENERGY RING-OPENING PROCESS IN THE REACTIONS OF ENERGETIC TRITIUM ATOMS WITH CYCLOPENTANE. Orchard, S.W.; Chou, C.C.; Rowland, F.S. (Department of Chemistry, University of California, Irvine, California 92664). J. Chem. Phys. 60: No. 6, 2567-2567 (15 Mar 1974).

Tritium atom reactions with gaseous c-C_5H_{10} were studied. The major products were HT and c-C_5H_9T, from abstraction and T-for-H substitution. Observed yields of tritium-labeled products from the reaction are given. (AIP)

12378 AFTEREFFECTS OF ELECTRON CAPTURE IN COBALT-57 ATOMS SORBED ON ANION-EXCHANGE RESINS. Ablesimov, N. E.; Bondarevskii, S. I. (Leningrad State Univ.). High Energy Chem. (USSR) (Engl. Transl.); 7: No. 6, 481-483 (1973).

Translated from Khim. Vys. Energ.; 7: No. 6, 546-548(1973).

Since identification of the composition and structure of the first and second coordination spheres of radioactive atoms under conditions of sorption on ion-exchange resins is difficult, systems obtained by sorption of complex anions of cobalt on anion-exchange resins were studied, the Moessbauer atoms having well-known qualitative and quantitative properties with respect to the first coordination sphere. Identification of the valence forms of the "hot" atoms and determination of their concentration ratios were carried out by means of Moessbauer emission spectra obtained at 77°K. (LK)

12379 NEW APPROACH TO SOME ASPECTS OF RECOIL TRITIUM CHEMISTRY. Malcolme-Lawes, D. J. (Kent Univ., Canterbury, Eng.). Radiochim. Acta; 19: No. 3, 113-120(1973).

The available data on the chemical reactions of tritium, produced by the $^3He(n,p)T$ process, with simple hydrocarbons were examined in the light of the prediction that HT produced by a high energy abstraction process may undergo dissociation on collision with surrounding molecules. Collisional dissociation may be invoked to resolve the apparent contradiction of the stripping model and the energy cut-off model of the abstraction process. The effective probability of HT production in different moderators is estimated using a hard sphere model, and the results correlate well with experimental data from He, Ne, Ar, Kr, Xe, N_2, CF_4 and D_2 moderators in ethane and methane. The bond energy effect on the abstraction yield, the results of experiments using photolytically produced tritium atoms and the magnitude of scavenger competition by bromine are related to the stripping model and collisional dissociation of excited HT. (GE)

12380 FAST SEPARATION IN THE GASEOUS PHASE OF Ru RECOIL PRODUCTS PRODUCED BY ^{252}Cf. I. Boegl, W.; Baechmann, K. (Technische Hochschule, Darmstadt, Ger.). Radiochem. Radioanal. Lett.; 17: No. 4, 239-250(15 Jun 1974).

The separation of Ru nuclides (produced by a ^{252}Cf source) in the gas phase has been investigated. The total yields are given as a function of the gas composition (N_2, H_2O, Cl_2, HCl), gas concentration, temperature of the cooling trap and temperature of the transfer tube. (auth)

12381 REPLACEMENT OF THE AROMATIC NITRO GROUP WITH HOT ^{38}Cl ATOMS. Kardos, Z.; Berei, K.; Vasaros, L. (Central Research Inst. for Physics, Budapest). Radiochem. Radioanal. Lett.; 17: No. 4, 233-238(15 Jun 1974).

Thermal and high-energy ^{38}Cl for nitro group replacement reactions in nitrobenzene and chloronitrobenzene systems were studied. The results of scavenger experiments and of medium effect investigations show that only 30-60% of nitro group replacement can be attributed to genuine hot atom reactions. (auth)

12382 ELECTROPHILIC SUBSTITUTION REACTIONS OF BROMINE IONS WITH HALOMETHANES IN THE GAS PHASE. Daniel, S. H.; Ache, H. J. (Virginia Polytechnic Inst. and State Univ., Blacksburg). Radiochim. Acta; 19: No. 3, 132-136(1973).

The electrophilic substitution reactions of $^{80}Br^+$, generated in the ^{80m}Br (IT) → ^{80}Br nuclear process, were studied under a variety of experimental conditions. In the gaseous CH_3Cl system about 0.6% of the total ^{80}Br produced replaced the Cl in CH_3Cl. H substitution is considerably smaller, only 0.19% of the total ^{80}Br generated is observed as $CH_2Cl^{80}Br$. Moderator and scavenger experiments suggest that the substitution occurs via a mechanism involving thermal ionic ^{80}Br species. Within the series of the halogenated methanes, CH_3Cl, CH_2Cl_2, $CHCl_3$, and CCl_4 the ^{80}Br for halogen and hydrogen substitution decreases with each additional chlorine atom present. In the monohalogenated methanes, CH_3X, (X = F, Cl, Br, I) the substitution yields increase with the mass of the halogen present in the molecule. Intramolecular competition for ^{80}Br substitution in CH_2ClBr shows the ^{80}Br for Br substitution favored over ^{80}Br for Cl substitution by the factor of about 1.3. (GE)

12383 ESR AND CHEMICAL BEHAVIOR OF IRRADIATED ANION-DOPED POTASSIUM CHROMATE. Milenkovic, S. M.; Veljkovic, S. R. (Institut za Nuklearne Nauke Boris Kidric, Belgrade). J. Inorg. Nucl. Chem.; 36: No. 3, 683-684(Mar 1974).

The influence of anion-doping on recoil and annealing processes was studied in potassium chromate doped with alkali halides and with phosphate (Milenkovic et al., Radiochim. Acta; 8: 146(1967) and 8: 222(1967)). An ESR study of irradiated anion-doped potassium chromate shows spectra with hyperfine splittings, which are superimposed on the spectrum of irradiated undoped chromate (Schara et al., J. Inorg. Nucl. Chem.; 32: 369(1970)). A parallel study of the ESR and chemical behavior of irradiated anion-doped potassium chromate was undertaken to supply evidence of the mechanism of the recoil and annealing processes. The experimental details and results are given. The retention measurements of the recoil ^{51}Cr after annealing are only partially correlated with the disappearance of the chromium signal component in the

ESR spectrum. Possible mechanisms are discussed. It is concluded that the fate of the recoil atoms depends a great deal on the state of the crystal target and that radiation annealing takes place as a process parallel and complementary to the thermal annealing. (UK)

Properties of Radioactive Materials

Refer also to abstracts 12382, 13027, 13064, 13065, 13103, and 13686.

12384 (AREAEE-188) SOME THERMAL SITUATION ASPECTS IN THE BOMB REDUCTION OF URANIUM TETRAFLUORIDE TO URANIUM METAL. Abou-Zahra, A. A.; Hammad, F. H. (Atomic Energy Establishment, Cairo (Egypt)). 1973. 50p. Dep. NTIS (US Sales Only) $5.50.

The thermal and thermodynamic conditions in bomb reduction of UF_4 are investigated. Preheating of the charge is stated to be necessary to bring some portion of the charge to ignition temperature (about 900°C) and all of the charge to an average temperature (about 400°C) high enough to assure molten products. In the preheating period, the liner and charge are treated as a homogenous, right circular cylinder; the temperature distribution in the charge as a function of the thermal properties, dimensions of the bomb, and the preheating time are calculated on an ICL digital computer. By the use of an analog computer, radial temperature-time profiles have been determined for the preheating period of the bomb reduction process. The effect on radial temperature-time profiles of liners and charges with different thermal properties was determined. (auth)

12385 URANIUM IN CARBONATE HYDROTHERMAL SOLUTIONS. Rafal'skii, R. P. Sov. J. At. Energy (Engl. Transl.); 34: No. 1, 36-37(Jan 1973).

Translated from At. Energ. (USSR); 34: No. 1, 29(Jan 1973). This is a summary of paper No. 633/6955 with full copy held by TIC.

Uranyl carbonate complexes are considered the basic compounds, in the form of which the transfer of uranium by natural hydrothermal solutions from the source to the site of formation of uranium ores occurred. The absence of instability constants for these complexes at increased temperatures has hindered the evaluation of their actual role in the hydrothermal process. A method of determining the equilibrium concentrations of the components and the composition of the $[UO_2(CO_3)_3]^{4-}$ complex is described. (LK)

12386 LABELLING, FRACTIONATION, AND TOXICITY OF SCORPION (LEIURUS QUINQUESTRIATUS H AND E) VENOM, USING ^{125}I, ^{131}I, AND GEL-FILTRATION TECHNIQUE. Abdel-Wahab, M. F.; Abdo, M. S.; Megahed, Y. M.; Osman, O. H. (Radioisotope Department, Dokki, Egypt). Isotopenpraxis; 10: No. 2, 56-58(Feb 1974).

Labelling the venom of scorpion was achieved by means of a technique previously published by the author. The radioisotopes used were both ^{125}I and ^{131}I in a nascent form. Fractionation was done by the use of Sephadex G-100. Both the radioactivity and the extinction curves denoted the presence of three well-defined peaks. The toxicity of the first fraction was found to be the most lethal. While the second peak was in the magnitude of 20% of the first, the third peak proved to be non-toxic to mice up to a concentration of 6 mg/kg body weight. (auth)

12387 COMPOUNDS OF THE TRANSURANIUM ELEMENTS. II. Koch, G. (Kernforschungszentrum, Karlsruhe, Ger.). Chem. Ztg.; 97: No. 12, 644-649(Dec 1973). (In German).

Following the discussion of the oxides, carbides and nitrides in Part I of this article (October issue), a short review is presented on the other binary compounds of the transuranium elements with non-metals: halides, hydrides, borides, silicides, germanides, phosphides, arsenides, sulfides, selenides, tellurides. Moreover mention is made of salts of inorganic and organic acids, and of complex compounds (acido complexes, chelates, metal organic compounds). (GE)

12388 PHOSPHINE OXIDE COMPLEXES OF THORIUM(IV), URANIUM(IV), NEPTUNIUM(IV), AND DIOXOURANIUM(VI) NITRATES. Bagnall, K. W.; Wakerley, M. W. (Manchester Univ., Eng.). J. Chem. Soc., Dalton Trans.; No. 3, 889-895(1974).

Complexes of the actinoid tetranitrates with phosphine oxides, $M(NO_3)_4$, xR_3PO (R = Me(tmpo), M = Th, U, x = 4 and M = Th, Np, x = 3; R = Pr^n(tprpo), M = Th, U, Np, x = 2.67; R = Bu^n(tbpo) M = Th, x = 4; R = Me_2N(hmpa), M = Th, U, Np, x = 2; R = Ph(tppo), M = Np, x = 2) and with the bidentate phosphine oxides, octamethylpyrophosphoramide (ompa), $Th(NO_3)_4$, 2.5 ompa and $M(NO_3)_4$, 1.5 ompa (M = Th, U, Np), bis(diphenylphosphinyl)methane (ppM), $Th(NO_3)_4$, 1.5 ppM and bis(diphenylphosphinyl)ethane, $Th(NO_3)_4$, 2 ppe, were prepared, along with the uranium(VI) analogues $UO_2(NO_3)_2$, xL (L = tprpo, x = 2; L = ppM, x = 1.5). The IR, Raman, and electronic spectra of these complexes are discussed. (auth)

12389 SHRINKAGE OF THE INTERNUCLEAR DISTANCES IN SOME HEXAFLUORIDES OF OCTAHEDRAL SYMMETRY. Nagarajan, G.; Adams, T. S. (Valdosta State Univ., GA). Monatsh. Chem.; 104: No. 6, 1607-1622(Nov 1973).

A brief analysis of the shrinkages or shortening of the internuclear distances in many molecular systems has been made. Analytical expressions for the linear shrinkage and nonlinear shrinkage were derived in terms of the mean square perpendicular amplitudes. Analytical expressions for the generalized mean-square amplitudes (mean-square parallel amplitudes, mean-square perpendicular amplitudes, and mean cross products) for an octahedral XY_6 molecule are given in terms of the mean-square amplitude matrices. The linear and nonlinear shrinkages for the hexafluorides of sulfur, selenium, tellurium, molybdenum, technetium, ruthenium, rhodium, tungsten, rhenium, osmium, iridium, platinum, uranium, neptunium, and plutonium, were computed at 298 and 500°K, and the results briefly discussed. (auth)

12390 EQUILIBRIA INVOLVING VOLATILE UO_2Cl_2. Cordfunke, E. H. P.; Prins, G. (Stichting Reactor Centrum Nederland, Petten). J. Inorg. Nucl. Chem.; 36: No. 6, 1291-1293(Jun 1974).

From third international conference on chemical thermodynamics; Baden, Germany (3 Sep 1973).

Direct chlorination of uranium oxides will give volatile UO_2Cl_2 under certain conditions of temperature, chlorine pressure, and oxygen pressure. When UO_2 is used as the starting material a number of side reactions occur, as are discussed in the paper. With U_3O_8, however, only volatile UO_2Cl_2 is formed, according to the equilibrium: $U_3O_8(s) + 3Cl_2(g) \rightleftharpoons 3UO_2Cl_2(g) + O_2(g)$. For the equilibrium constant of the reaction it has been found, using the transportation method: $\log K_p(mm) = [(-31,100 \pm 350)/T] + 17.70 \pm 0.30$(860-1055°C). (auth)

12391 KINETIC STUDY OF A REDOX REACTION OF U(III) IONS WITH BENZALDEHYDE AND SALICYLALDEHYDE. Adamcikova, L.; Treindl, L. (Comenius Univ., Bratislava). Collect. Czech. Chem. Commun.; 39: No. 5, 1264-1270(May 1974).

The kinetics, stoichiometry, and mechanisms of redox reactions of U(III) ions with benzaldehyde and with salicylaldehyde in perchloric acid solutions were studied. The forms of the rate laws were examined and the stoichiometry determined with the help of polarometric titration and analysis of reaction products. The first reaction is acid catalyzed, while the rate of the other reaction depends only very slightly on the concentration of hydrogen ions. Kinetic data, obtained polarographically, give the basis for discussion of the possible reaction mechanisms. (auth)

12392 KINETIC STUDY OF THE REACTION Np(VII) + V(IV) → Np(VI) + V(V) IN AQUEOUS PERCHLORIC ACID MEDIA. Watkins, K. O.; Sullivan, J. C.; Deutsch, E. (Univ. of Rhode Island, Kingston). Inorg. Chem.; 13: No. 7, 1712-1715(Jul 1974).

The title reaction was investigated by the stopped-flow technique as a function of acidity, ionic strength, and temperature. At constant $[H^+]$ the empirical form of the rate law is $-d[Np(VII)]/dt = k''[Np(VII)][VO^{2+}]$ where k'' exhibits only a slight acid dependence most conveniently expressed as $\log k'' = \log k + n \log [H^+]$. At 25° and $\mu = 1.00$, with k' expressed in units of F^{-1} sec^{-1}, $\log k = 3.159 \pm 0.005$ and $n = -0.112 \pm 0.076$. The temperature dependence of k over the range 2.7 to 25°C results in a value of 7.3 ± 0.9 kcal/mol for the Arrhenius activation energy. Rate parameters for the title reaction, which is of one-to-one stoichiometry, are compared to the corresponding parameters governing the two-to-one oxidation of Hg_2^{2+} by Np(VII), as well as to the corresponding parameters governing the one-to-one oxidation of VO^{2+} by the relatively weak oxidant Mn(III). While the relative rates of these reactions are reflected primarily in ΔH^*, the importance of considering S^* as well as ΔS^* values is pointed out. It is also qualitatively noted that of the reported oxidations of VO^{2+}, that by Np(VII) is the most rapid and NP(VII) is the most powerful oxidant. (auth)

12393 ABSORPTION SPECTRUM, LIFETIME, AND PHOTOREACTIVITY TOWARDS ALCOHOLS OF THE EXCITED STATE OF THE AQUEOUS URANYL ION (UO_2^{2+}). Hill, R. J.; Kemp, T. J.; Allen, D. M.; Cox, A. (Warwick Univ., Coventry). J. Chem. Soc., Faraday Trans., I; 70: No. 5, 847-857(1974).

Microsecond flash photolysis of solutions of uranyl salts in water, H_3PO_4, H_2SO_4 and other media yields an intense, but short-lived transient absorption spectrum in the region of 570 nm, which exhibits vibronic structure with an average band separation of 580 cm^{-1}. The decay of the transient in water was determined

by laser flash photolysis to be first order with $k_1 = 8.02 \times 10^5\ s^{-1}$, but with a considerable isotope effect ($k_{1(D_2O)} = 4.20 \times 10^5\ s^{-1}$). The value for k_1 accords with the lifetime of the luminescence of aqueous UO_2^{2+} ion determined by single photon counting ($k_1 = 3.85 \times 10^5\ s^{-1}$). Both the 570 nm absorption and the emission (as determined by both single photon counting and conventional fluorimetry) are quenched on addition of various alcohols, the Stern-Volmer quenching constants closely correlating with the absolute quenching constants for the transient determined by laser flash photolysis. Large isotope effects were found for quenching by deuterated methanol, isopropanol and cyclohexanol both of the transient absorption and the emission. It is concluded that the same electronic state of UO_2^{2+} is responsible for (i) emission to the ground state, (ii) the absorption at 570 nm to a higher excited state and (iii) the photo-oxidation of aliphatic alcohols, principally by a process of abstraction of an H atom bonded to carbon from a $-CH_2OH$ or $=CHOH$ group. (auth)

12394 KINETICS OF THE OXIDATION OF HYDROQUINONE BY Pu(VI) AND BY Pu(IV) IN AQUEOUS PERCHLORATE SOLUTIONS. Newton, T. W. (Los Alamos Scientific Lab., NM). J. Inorg. Nucl. Chem.; 36: No. 3, 639-643(Mar 1974).

The reduction of Pu(VI) and Pu(IV) has been studied in aqueous perchlorate solutions. The reactions go to completion with the reduction of two moles of plutonium for each mole of hydroquinone oxidized. The kinetics are quite complicated: the rate laws show inhibition by the reduced plutonium species, but not by quinone, and for Pu(VI) is approximated by: $-d[\text{hydroquinone}]/dt = k_1[Pu(VI)][\text{hydroquinone}]/(1 + a[Pu(V)]/[Pu(VI)] + b([Pu(V)]/[Pu(VI)])^2)$. The same form, with different values for the parameters, is observed for Pu(IV). For Pu(VI), k_1 is $1.6 \times 10^3\ M^{-1}\ sec^{-1}$ at 25° in 1 M $HClO_4$, depends inversely on $[H^+]$, and has an activation energy of 15.7 ± 0.1 kcal/mole. For Pu(IV), k_1 is about 9.6×10^4 under the same conditions, is essentially independent of $[H^+]$, and has an activation energy of 12 ± 1 kcal/mole. The results are compared with those for other metal ion oxidizing agents. (auth)

12395 POLAROGRAPHIC BEHAVIOR AND DETERMINATION OF KINETIC PARAMETERS FOR THE ELECTRODE REACTION OF URANYL-PAMOATE COMPLEX IN DIMETHYL SULFOXIDE. Lai, T. T.; Kuu, W. Y. (Cheng Kung Univ., Taiwan, China). J. Inorg. Nucl. Chem.; 36: No. 3, 631-637(Mar 1974).

Uranyl-pamoate complex in dimethyl sulfoxide solution gives two reduction waves at pH 4.0 to 5.0 and pH 5.8 to 8.5, respectively. The first wave is the reduction of $UO_2(Dm)_2Pm$ species when [DMSO] ≤ 60 vol. %; however, it was proved to be the simultaneous reduction of the two species $UO_2(Dm)_2^{+2}$ and $UO_2(Dm)_2Pm$ when [DMSO] > 70 vol. %. The second wave is quasi-reversible, corresponding to the reduction of $UO_2(OH)(Dm)_4Pm^-$ species. The electron transfer coefficients, rate constants of electroreduction and electro-oxidation, and polarographic overpotentials were determined. The hydrolysis constants of uranyl ion in dimethyl sulfoxide concentrations 50 to 70 vol. % at pH 4.0 to 4.8 were determined. (auth)

12396 CHEMISTRY OF URANIUM. IX. Uranium Tetrahalide Complexes of Lactam Ligands. Du Preez, J. G. H.; Gibon, M. L.; Steenkamp, P. J. (Port Elizabeth Univ., South Africa). J. Inorg. Nucl. Chem.; 36: No. 3, 579-584(Mar 1974).

Lactam complexes of thorium and uranium tetrahalides, $ThCl_4(aco)_4 \cdot$ acetone, $ThI_4 \cdot 8L$, $UCl_4 \cdot 4L$, $UBr_4(pip)_6$, $UBr_2(pip)_6(ClO_4)_2$ and $UI_4 \cdot 8L$, where L is 2-piperidone (pip), 1-aza-cyclooctan-2-one(aco), and ε-caprolactam (cl) were isolated. These compounds were characterized by spectroscopic and magnetic susceptibility measurements. The various equilibria resulting from the interactions of uranium(IV), halide, solvent, and 2-piperidone were studied by conductometric and spectrophotometric methods. These indicated that eight coordinated uranium(IV) complexes crystallized out of solutions containing a large amount of octahedral uranium (IV). (auth)

12397 RELATIONS BETWEEN SUCCESSIVE STABILITY CONSTANTS OF COMPLEX IONS OF ACTINIDES. Moskvin, A. I. Sov. Radiochem. (Engl. Transl.); 15: No. 4, 504-510(1973).

Translated from Radiokhimiya; 15: No. 4, 497-504(1973).

By use of the numerous data on the overall stability constants of acido complexes of actinides their successive stability constants were calculated. The values for the successive constants calculated from empirical equations were tabulated and compared with the experimental data. By examining the relations between the successive constants some information was obtained on the steric configuration of acido complexes of actinides and the effect of various factors on the value of $\log x_n/x_{n+1}$. (auth)

12398 THERMODYNAMIC CHARACTERISTICS OF FORMATION OF ACTINIDE IONS IN AQUEOUS SOLUTIONS. Moskvin, A. I. Sov. Radiochem. (Engl. Transl.); 15: No. 4, 511-518(1973).

Translated from Radiokhimiya; 15: No. 4, 504-513(1973).

New calculated data were obtained on the thermodynamic characteristics of the formation of actinide ions in aqueous solutions. It was established that there is a relation between ΔS_{hydr}, ΔH_{hydr}, and the electrostatic characteristics (Z and r), as is shown by the corresponding equations. Definite rules were found and interpreted for the changes in the entropy, enthalpy, and free energy in the complex formation of actinide ions. The effect of various factors on the thermodynamic functions was established. Equations are proposed for the relation between the ionization potentials and ionic radii of the actinides and the atomic numbers of the elements, i.e., their positions in the Periodic Table. The heat capacities of triply charged actinide ions and also the changes in their heat capacities on hydration and when transferred from the crystal lattice to a solution were calculated. (auth)

12399 KINETICS OF REDUCTION OF NEPTUNIUM(V) BY OXALIC ACID. Shilin, I. V.; Rumyantseva, T. A. Sov. Radiochem. (Engl. Transl.); 15: No. 4, 519-525(1973).

Translated from Radiokhimiya; 15: No. 4, 513-521(1973).

A study was made of the kinetics of reduction of neptunium(V) by oxalic acid in perchloric acid solutions with $\mu = 2$ at 68°C. The reaction rate increases with an increase in the concentrations of neptunium(V) and oxalic acid and falls with an increase in the concentration of hydrogen ions. The order of reaction with respect to oxalic acid is fractional and equals ~1.6, that with respect to neptunium varies over the range from 1 to 2, while that with respect to the hydrogen ion varies from −1 to −1.8. A reaction mechanism is proposed in which the reduction of neptunium(V) proceeds by three parallel routes. The first is the direct reduction of $Np^{(V)}$ by oxalic acid and the other two routes lie through the disproportionation of neptunium(V). The general kinetic equation of the process has the form: $-[d(Np^{(V)})]/dt = k_1[(C_2O_4^{-})(H^+) \times (Np^{(V)})]/[1 + \beta_1(C_2O_4^{-}) + \beta_2(C_2O_4^{-})] + k_2[(C_2O_4^{-})^2(H^+)^2(Np^{(V)})^2]/[1 + \beta_1(C_2O_4^{-}) + \beta_2(C_2O_4^{-})^2]^2 + k_3[(C_2O_4^{-})^2(H^+)(Np^{(V)})^2]/[1 + \beta_1(C_2O_4^{-}) + \beta_2(C_2O_4^{-})^2]^2$. At 68°C with $\mu = 2$, $k_1 = 1900\ min^{-1}\ M^{-2}$, $k_2 = 3.2 \cdot 10^{12}\ M^{-5}\ min^{-1}$, and $k_3 = 4 \cdot 10^{14}\ M^{-4}\ min^{-1}$. A study was made of the temperature dependence of the rate of the process over the range of 32−68°C. The values of the activation energies for the 1st, 2nd, and 3rd routes were $E_1 = 12$ kcal/mole, $E_2 = 21$ kcal/mole, and $E_3 = 25.6$ kcal/mole. (auth)

12400 PREPARATION OF MULTIPLY LABELED TRITIATED BENZENE. Nefedov, V. D.; Sinotova, E. N.; Korsakov, M. V.; Alekseev, E. G. Sov. Radiochem. (Engl. Transl.); 15: No. 4, 641-642(1973).

Translated from Radiokhimiya; 15: No. 4, 635-636(1973).

A microsynthesis was carried out for the first time of carrier-free multiply labeled tritiated benzene by means of an aluminum−nickel−molybdenum catalyst. It was shown that the reaction product of phenyl cations formed as a result of the β-decay of tritium in the benzene molecule is biphenyl. (auth)

12401 SYSTEM $HF-UF_6-NH_4F$. Opalovskii, A. A.; Kuznetsova, Z. M.; Nesterenko, M. N.; Shingarev, V. G. Sov. Radiochem. (Engl. Transl.); 15: No. 4, 616-618(1973).

Translated from Radiokhimiya; 15: No. 4, 615-618(1973).

The system $HF-UF_6-NH_4F$ was investigated by the isothermal solubility method. The solubility isotherm of the system $HF-UF_6-NH_4F$ consists of three branches, corresponding to three different solid phases. On the section of the isotherm up to 13.64% NH_4F in the solution the solid phase is the starting uranium hexafluoride and the maximum solubility of UF_6 on this section is 8.01%. On the second section of the isotherm from 13.64 to 27.99% NH_4F in the solution there is first a slight fall in the solubility of UF_6 to 7.35% with an ammonium fluoride concentration in the solution of ~20% and then a gradual rise to 15.05% at an NH_4F concentration of 27.99%. On this branch of the isotherm there appeared as the solid phase a compound with the composition NH_4UF_7 (calculated: NH_4F 9.51, UF_6 90.49%, determined by analytical extrapolation of the Schreinemakers lines: NH_4F 10.59, UF_6 89.41%), analogous to one of the compounds of the system $HF-MoF_6-NH_4F$. The third section of the solubility isotherm of the system $HF-UF_6-NH_4F$ corresponds to a solid phase with the composition $NH_4F \cdot 3HF$. (LK)

12402 ir ABSORPTION SPECTRA OF SOME NEPTUNIUM COMPOUNDS. IV. Oxalate Compounds. Kharitonov, Yu. Ya.; Moskvin, A. I. Sov. Radiochem. (Engl. Transl.); 15: No. 4, 608-611(1973).

Translated from Radiokhimiya; 15: No. 4, 608-612(1973).

The ir absorption spectra (400−4000 cm^{-1}) of a series of oxalate compounds of neptunium (IV, V, VI) were obtained and discussed. (auth)

12403 SOME RULES OF CHELATE FORMATION OF THORIUM IN SOLUTIONS OF AMINO ACIDS AND COMPLEXONS. Sergeev, G. M.; Korshunov, I. A. Sov. Radiochem. (Engl. Transl.); 15: No. 4, 619-622(1973).

Translated from Radiokhimiya; 15: No. 4, 621-623(1973).

The effect of the structure of amino acids and complexons on the stability of thorium complexes was investigated. The complex forming power of amino monocarboxylic acids is evidently determined by the basicity of the latter and also the relative position of the α- or β-coordinating nitrogen and oxygen atoms. (MCG)

12404 PECULIARITIES IN THE REACTION OF THE URANYL ION WITH AMINO ACIDS AND COMPLEXONS. Sergeev, G. M.; Korshunov, I. A. Sov. Radiochem. (Engl. Transl.); 15: No. 4, 623-626(1973).

Translated from Radiokhimiya; 15: No. 4, 621-623(1973).

The relation between the stability of complexions of hexavalent uranium and the structural peculiarities of some amino acids and complexons is demonstrated. The composition and stability constants of the amino acid complexes of uranyl were determined by pH potentiometry and spectrophotometry with a constant ionic strength $\mu = 0.5$ and $t = 25°C$. The predominant factor affecting the stability of the chelates is the relative arrangement of the donor atoms of the ligand and the uranyl ion. (MCG)

12405 ENTROPY CHARACTERISTICS OF STRUCTURAL CHANGE OF WATER FROM HYDRATION OF LANTHANIDE AND ACTINIDE IONS IN THE RANGE 0 TO 100°C. Krestov, G. A.; Kobenin, V. A. Sov. Radiochem. (Engl. Transl.); 15: No. 4, 526-529(1973).

Translated from Radiokhimiya; 15: No. 4, 521-524(1973).

On the basis of the I-I dividing line changes were calculated in entropy associated with structural changes in water from the hydration of lanthanide and actinide ions in the range of 0 to 100°C. On the basis of the II-II dividing line for the same ions the changes in entropy associated with the structural changes of water in the region of short-range hydration were calculated. The peculiarities of the change in these characteristics were examined in relation to the basic parameters of lanthanide and actinide ions (charge and radius) and the temperature. (auth)

Radioactive Waste Treatment

Refer also to abstract 13298.

12406 (BNWL-1825) STUDIES ON MANAGEMENT OF SELECTED WASTES. Quarterly Progress Report, January-March 1974. Schneider, K. J. (comp.). (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Apr 1974. Contract AT(45-1)-1830. 54p. Dep. NTIS $4.00.

Progress in studies on the management of low-level radioactive wastes is reported with information on the decontamination and densification of chop-leach cladding residues, waste treatment and handling processes, and tritium separation and fixation. (auth)

12407 (HIT-516) RADIOACTIVE WASTE MANAGEMENT: A SURVEY. (Hittman Associates, Inc., Columbia, Md. (USA)). May 1972. Contract 68-04-0052. 429p.

The 1891 references, both domestic and foreign, published from 1955 to 1972, were surveyed to compile and organize information on processes for treating liquid and gaseous radioactive wastes produced by nuclear power plants and fuel reprocessing plants. Economic and performance data and detailed descriptions are included on 11 specific liquid waste treatment processes and 6 specific gaseous waste treatment processes plus more general discussions of other processes for treating gaseous and liquid radioactive wastes. For each process, information is included on performance parameters, decontamination factors, economics, and process flow sheets. The complete bibliography is included with each reference numbered. A cross index from specific subjects to the bibliography reference number is provided. (LCL)

12408 (HW-81710) TEST COLUMN FOR RECOVERY OF PLUTONIUM FROM CAC-880 WASTE STREAM. Creighton, D. M. (General Electric Co., Richland, Wash. (USA). Hanford Atomic Products Operation). 7 Apr 1964. Contract AT(45-1)-1350. 15p. Dep. NTIS $4.00.

The purpose of the work described in this report was to prepare a test extraction column for plutonium and operate it under simulated plant conditions; examining operating parameters such as organic concentration, flow rate, and feed concentration; and to provide such data as would be required to prepare a flow sheet. (LK)

12409 (KFK-1830) DECONTAMINATION DEPARTMENT: ANNUAL REPORT, 1971. Krause, H. (Kernforschungszentrum Karlsruhe (F. R. Germany). Abt. Dekontaminationsbetriebe). Jun 1973. 120p. (In German). INIS.

The activities of different groups (laboratory group, project group, operational group) of the decontamination department of the Nuclear Research Center of Karlsruhe are surveyed. In particular, laboratory experiments for processing and solidification of radioactive wastes, pilot plants for waste vitrification and bituminization, decontamination experiments with stainless steels and operational decontamination measures, preliminary studies for the disposal of tritium-containing waste waters by pumping them into an exhausted oil lens, and finally, the promoting activities in the test storage of radioactive wastes in the Asse salt mine are described. (GE)

12410 SOLIDIFICATION OF INTERMEDIATE- AND LOW-LEVEL RADIOACTIVE WASTES. Nomi, M. (Ebara Mfg. Co. Ltd., Tokyo). FAPIG (Tokyo); No. 70, 103-109(Aug 1973). (In Japanese).

The radioactive wastes from nuclear power generation, such as from BWRs and PWRs, are treated and disposed on land or in the ocean. Here arises the need for their solidification. The solidification with concrete and asphalt of intermediate- and low-level wastes is described on the comparison of process and characteristic features. In BWRs and PWRs, the wastes are mainly ion-exchange resin, concentrated liquid, filter cake, etc. While the concrete solidification is rather established because of its usual practice in industries, the asphalt process is being developed in Europe in particular. Selection of concrete or asphalt is determined not only by the types of wastes, but also by such factors as the volume and weight of both wastes and final solids. (JA)

12411 SOLIDIFICATION OF RADIOACTIVE WASTES WITH CEMENT. Murata, J.; Otsuka, S. (Tokyo Metropolitan Univ.). Semento Konkurito; No. 322, 26-32(Dec 1973). (In Japanese).

With the advance of nuclear power generation, the treatment and disposal of radioactive wastes become extremely important. As for nuclear power plants, main reactors are PWRs and BWRs, and the radioactive wastes produced are waste liquid, sludge and spent ion-exchange resin. For the disposal in ocean, their solidification with cement is used. The solids of cement have been studied experimentally on the mechanical stability against the pressure in deep sea, long-term chemical stability at sea bottom, and elution of radioactive substance, in order to see the safety of cement-solidification disposal. The uniaxial strength of the solids with ion-exchange resin, considering the internal loosening under the pressure in deep sea, must be over 40% of design hydraulic pressure and that of the other uniform solids must be over 20%. The chemical stability concerning solid integrity may be obtained by using suitable mixing. The degree of elution from the solids should be evaluated after 28 days of curing; in this case, the cement solid is not inferior to asphalt solid. (JA)

12412 STUDIES ON DINONYLNAPHTHALENE SULPHONIC ACID AS LIQUID ION EXCHANGER FOR RADIOACTIVE LIQUID DISPOSAL. II. Wang, S. M.; Tseng, C. L.; Hus, C. N.; Weng, P. S. (National Tsing Hua Univ., Hsinchu, Taiwan). Radioisotopes (Tokyo); 22: No. 9, 497-502(Sep 1973).

A simple yet effective method for radioactive waste treatment was developed by using dinonylnaphthalene sulfonic acid as a liquid cation exchanger. The removal efficiency of radioactive elements can increase to 99% by using a single column in which only pieces of crushed porcelain or porous plates are placed and bubbled with compressed air. The batch method with air stirring or mechanical stirring is also highly effective. The preadjustment of the acid concentration plays an important role in using this method; the optimum concentration was found to be less than 0.001 N and not lower than 0.0001 N. (auth)

12413 O_2 FOR CALCIFICATION OF RADIOACTIVE WASTES. Holcomb, W. F.; Wielang, J. A. (Allied Chemical Corp., Idaho Falls, ID). Cryog. Ind. Gases; 8: No. 4, 24-25(1973).

Heat for the endothermic calcination process at the Idaho Chemical Processing Plant's Waste Calcining Facility is supplied by the in-bed combustion of kerosene using vaporized liquid oxygen. Pure vaporized liquid oxygen is used to keep the superficial fluidizing velocities below one foot per second. The oxygen storage unit is a cryogenic tank capable of containing about 6000 gallons of liquid oxygen at a working pressure of 250 psig. The heat to calcine 36,000 gallons per day of radioactive aqueous waste is provided. (MCG)

Radioisotope Production

Refer also to abstracts 12246 and 12416.

12414 (AAEC/E-321) IMPROVED DISTILLATION SEPARATION FOR THE PRODUCTION OF FLUORINE-18 FROM REACTOR IRRADIATED LITHIUM CARBONATE. Robson, J.; Sorby, P. J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). May 1974. 9p. Dep. NTIS (US Sales Only) $4.00.

A process is described whereby ^{18}F of pharmaceutical quality can be rapidly isolated from irradiated lithium carbonate by distillation under controlled conditions. By this method a consistent, high yield of ^{18}F can be obtained in a solution containing reproducible concentrations of sodium sulfate and carbonate. (auth)

12415 NEW LABELLING METHODS WITH RADIOISOTOPES FOR TECHNICAL APPLICATION. Akerman, K.; Sauerwein, K. (Isotopen-Technik Dr. Sauerwein GmbH, Dusseldorf). Atomwirt., Atomtech.; 19: No. 3, 137-142(Mar 1974). (In German).

Labelling methods with radioactive tracers are not as widely applied in technology as in medicine. The difficulty of obtaining radioisotopes from the reactor or accelerator just at the right time and in the chemical composition and the activity asked for, is an important hindering factor in its technical application. The authors propose as a solution to the problem, the application of radioisotope generators ("cow-milkers") which allow the application of a suitable daughter nuclide directly at the place of experiment. With an extensive supply of mother nuclides a great variety of technical problems can be met. Some examples are given for the technical use of a Sn-113/In-113m generator, and the possibilities of labelling methods in different branches of industry. (GE)

12416 PROBLEMS IN THE CHROMATOGRAPHIC PURIFICATION AND PREPARATION OF SOURCES OF TRANSPLUTONIUM ELEMENTS. Vdovenko, V. M.; Krivokhatskii, Belov, L. M.; Aleksandrov, B. M. Sov. Radiochem. (Engl. Transl.); 15: No. 4, 539-545(1973).

Translated from Radiokhimiya; 15: No. 4, 534-542(1973).

A study was made of the distribution of americium, curium, and californium between alcohol solutions containing hydrogen chloride and the strongly-basic anion exchange resin Dowex-1X4. By using the system anionite–96.6 to 99.3% ethanol containing 2 M HCl high absorption of transplutonium elements (TPE) was achieved with distribution coefficients of 10^3-$3 \cdot 10^4$, while impurity elements such as aluminum, magnesium, calcium, copper (II), and iron (III) are hardly absorbed under these conditions ($K_{d_{Fe^{3+}}} \sim 20$-30). The californium obtained in high yield as a result of this chromatographic purification contained an amount of impurities of only the same order as the amount of californium itself. A study was made of the electrolytic isolation of californium from weakly acidic solutions with different electrolyte pH values, cathode current densities, and electrolysis times and the optimal conditions were selected for quantitative isolation of californium in two stages (through a paddle cathode) on metal backings and for berkelium in one stage from weakly acidic solutions directly onto metal backings for layers with a density of 1-5$\mu g/cm^2$, including impurities (metal salts). The use of chromatographic purification of TPE concentrates and 2-stage electrodeposition under the conditions given above makes it possible to prepare targets or sources of TPE with a layer of good quality. (auth)

12417 CHROMATOGRAPHIC SEPARATION AND PURIFICATION OF TRACER AMOUNTS OF URANIUM-237 AND PLUTONIUM-241. Belov, L. M.; Krivokhatskii, A. S.; Lazarev, K. F.; Nechai, G. N.; Nikolaev, D. S. Sov. Radiochem. (Engl. Transl.); 15: No. 4, 627-628(1973).

Translated from Radiokhimiya; 15: No. 4, 624-625(1973).

The isolation and purification of the isotope ^{237}U was carried out in the following way. A 50-mg sample of a mixture of heavy isotopes of plutonium ($^{240-242}Pu$), containing about 10% ^{241}Pu, was sorbed on a column 6 × 100 mm with the anion exchange resin Dowex-1 × 8 (100-200 mesh) in the form of the nitrate complex of tetravalent plutonium from 7 M nitric acid. For the removal of traces of fission products contained in the preparation the column was washed with 7 M HNO_3 (24 ml) at a rate of 2 drops per min until the β- and γ-activity disappeared from the eluate and the α-background was constant. The column with the plutonium was then left for 10–14 days for the accumulation of ^{237}U and then the ^{237}U was eluted by passing 7 M HNO_3 through the column at a rate of 2 drops per min. (LK)

12418 RAPID THERMOCHEMICAL METHODS OF ISOLATING RADIOACTIVE ELEMENTS. I. Preparation of Radioactive Isotopes of Rhenium. Bayar, B.; Zaitseva, N. G.; Novgorodov, A. F. Sov. Radiochem. (Engl. Transl.); 15: No. 4, 557-562(1973).

Translated from Radiokhimiya; 15: No. 4, 553-560(1973).

By means of radioactive tracers a study was made of the gas thermochromatographic behavior of rhenium in the thermal decomposition of the crystalline salt NH_4ReO_4 in relation to various experimental conditions (temperature, time, carrier gas flow rate). On the basis of the results obtained we developed a rapid method of obtaining radioactive rhenium preparations from NH_4ReO_4 targets irradiated with 660-MeV protons. The volatile oxides of macroamounts of osmium and microamounts of rhenium may be separated by gas thermochromatography in order to use metallic osmium as a target for the preparation of radioactive rhenium in a carrier-free state. The temperature at which volatile compounds of rhenium are deposited was found to depend on the concentration of rhenium and water vapor. (auth)

Reactor Fuel Reprocessing

Refer also to abstract 14519.

12419 (CNEA-EN-33-105) PROGRAM OF ACTIVITIES OF A REPROCESSING DEPARTMENT. Tentative Project. Kaufmann, F. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). May 1973. 18p. (In Spanish). INIS.

A plan of action is proposed for the Reprocessing Department of the CNEA, which is in the process of completing the design conception preliminary plans for an industrial reprocessing plant. Data necessary for formulating the technical specifications will be prepared. The space, budget, and personnel necessary to complete the plan are listed. (tr-auth)

12420 (EUR-5062) EUREX EURATOM–CNEN AGREEMENT. Annual Report, 1971. Calleri, G.; Mozzetti, P. (Comitato Nazionale per l'Energia Nucleare, Milan (Italy)). May 1974. 17p. (In Italian). Dep. NTIS (US Sales Only) $4.00. EUR FB 40.-.

This report covers the seventh year of the Eurex Project since the signing of the ECAE-NCNE Convention No. 001-64-11 RCII on the construction, operation, and utilization of the Eurex plant for industrial research purposes. The report contains a summary of the three four-monthly reports published in 1971 and a brief general outline of the costs. The subject matter is arranged as follows: (a) management of the program; (b) planning and construction of the plant; (c) dry runs; (d) laboratory and pilot trials and experiments before commissioning the plant; and (e) industrial operation of the plant. (auth)

12421 SEPARATION OF URANIUM AND PLUTONIUM FROM NUCLEAR FUEL SOLUTIONS THROUGH EXTRACTION CHROMATOGRAPHY. Hermann, A.; Huebener, S.; Dreyer, R. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Isotopenpraxis; 10: No. 2, 62-66(Feb 1974). (In German).

The development of an extraction-chromatographic method of cleaning samples for mass-spectrometric isotopic analyses of uranium and plutonium is described. On a separation column uranium and plutonium are isolated from nuclear fuel solutions to be free from cationic admixtures, fission product decontamination being provided to a large extent. Out of several available materials some PTFE material had been chosen as a stationary phase carrier. Within the 100% TBP/HNO_3 distribution system, H_2SO_3 was used for the selective reduction of plutonium on the column. Possibilities to improve fission-product separation were investigated. (auth)

12422 CHEMICAL REPROCESSING OF NUCLEAR FUEL BY AQUEOUS METHODS. Heyne, W. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie; 17: No. 3, 65-70(Mar 1974). (In German).

The purex process has succeeded in wet-chemical reprocessing of nuclear fuels. Research and development works recently focus on equipment of high reliability and durability, radiation effects on extraction systems, simplification of the technological flowsheets, reduction of waste volume, and restriction of radioiodine release. Difficulties arising from reprocessing of highly enriched and highly burnt up fuels are tried to overcome by shortening phase contact time. Utilization of valuable by-products becomes more and more important. (auth)

12423 BEHAVIOR OF RUTHENIUM IN FLUORIDE-VOLATILITY PROCESS. I. Fluorination of PuO_2–RuO_2 Mixture and Recovery of Plutonium by Thermal Decomposition. Sakurai, T.; Takahashi, A.; Komaki, Y. (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 11: No. 2, 74-76 (Feb 1974).

This study was carried out in order to obtain more detailed information on the behavior of ruthenium in the fluorination of PuO_2 and the thermal decomposition of PuF_4. (LK)

12424 FLUORIDE DETERMINATION IN PUREX PROCESS SOLUTIONS. Ertel, D.; Knittel, G.; Herling, I. (Kernforschungszentrum, Karlsruhe, Ger.). (1973). vp. (In German).

From meeting of the Gesellschaft Deutscher Chemiker on trace analysis; Erlangen, Germany (2 Apr 1973).

In order to avoid the formation of zirconium butylphosphate precipitates in Purex Process solutions, one can convert the zirconium to the complex ZrF_7^{3+} by addition of HF. The amount of fluoride just sufficient to form this complex must carefully be met. For this reason the authors have chosen an analytical

method that separates the fluoride from the process solution by steam distillation (as H_2SiF_6), and determines the fluoride in the buffered distillate by measuring the fluoride potential using a specific electrode. The distillation procedure as well as the equipment used are described. Furthermore, the influence of the solution partners, which may be present in practice, on the measurement of the fluoride potential is shown. (GE)

12425 REPROCESSING OF NUCLEAR FUELS: SOLIDIFICATION OF RADIOACTIVE WASTES. Wasser, Luft Betr.; 16: No. 6, 193-194(Jun 1972). (In German).

The reprocessing of nuclear fuels and solidifying of radioactive wastes were discussed at the 186th DECHEMA seminar in Frankfurt in early March 1972. Economical energy production using nuclear reactors will necessitate measures for reprocessing fuels, such as reclaiming fissionable fuels like U and Pu; separation of these fuels and transfer to a suitable form for safe storage; and isolation of radioactive substances such as Cm. The disposal of radioactive waste waters, and the solidifying of radioactive wastes by setting them in cement or bitumen, are also discussed. (Pollut. Abstr.)

CONTROLLED THERMONUCLEAR RESEARCH

12426 (ANL-Trans-952) SHORT DESCRIPTION OF THE THERMONUCLEAR FACILITIES OF THE I. V. KURCHATOV INSTITUTE FOR NUCLEAR ENERGY. Romanovskii, M. K. (ed.). (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). May 1974. Translation of IAE-2314. 30p. Dep. NTIS $4.50.

Short descriptions are given for 28 facilities at the Institute. Technical characteristics and some results from each experiment are given. (MOW)

12427 (IPP-Bib-30) QUARTERLY TITLE LIST OF REPORTS, ETC., FOR THE PERIOD ENDING JUNE 1972. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (F. R. Germany)). 1972. 45p. INIS.

A collection of 85 English abstracts of papers published, submitted or presented at conferences by members of the plasma physics institute arranged according to literature types (reports, journal articles and lectures) is presented. (GE)

12428 (IPP-Bib-31) QUARTERLY TITLE LIST OF REPORTS, ETC., FOR THE PERIOD ENDING SEPTEMBER 1972. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (F. R. Germany)). 1972. 54p. INIS.

A collection of abstracts of reports (24), journal articles (54), and conference papers (52) prepared or published by members of the Max-Planck-Institute for Plasma Physics during the third quarter of 1972 is presented. (GE)

12429 (IPP-Bib-32) QUARTERLY TITLE LIST OF REPORTS, ETC., FOR THE PERIOD ENDING DECEMBER 1972. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (F. R. Germany)). [nd]. 47p. INIS.

A collection of abstracts of reports (18), journal articles (50) or lectures (45) which have been published, submitted or held by members or guests of the Institute during the last quarter of 1972 is presented. (GE)

12430 (IPP-Libr-34) QUARTERLY TITLE LIST FOR THE PERIOD ENDING JUNE 1973. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (F. R. Germany)). 1973. 50p. INIS.

A compilation of abstracts of publications, arranged by publication type reports (12), journal articles (28), manuscripts submitted for publication (22), and conference papers or lectures (63) is presented. (GE)

Confinement and Heating

Refer also to abstracts 12516, 12564, and 12596.

12431 (EUR-CEA-FC-711) POSSIBILITY OF HEATING TFR PLASMAS BY THE ABSORPTION OF FAST MAGNETOHYDRODYNAMIC WAVES. Adam, J. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Groupe de Recherches sur la Fusion Controlee). Oct 1973. 59p. (In French). Dep. NTIS (US Sales Only) $6.00.

The possibility of heating a TFR plasma using fast magnetohydrodynamic modes (magnetoacoustic waves) is examined. The characteristics of the dispersion relation and the charge impedance of an antenna capable of emitting these modes are considered together with the heating effects produced by these waves in the regions of the ion cyclotron resonance frequency and its second harmonic. Temperature rise calculations were effected for the plasma on the basis of the following hypotheses: the diffusion coefficients for the particles are negligible; the energy diffusion coefficients for the ions are neoclassical; the energy diffusion coefficients for the electrons are equivalent to the neoclassical coefficients multiplied by a factor of 30 in the "plateau" regime and by a factor of 135 in the banana regime; the hf heating is applied after the establishing of a stationary plasma by ohmic heating. It is shown that the wave can be excited in the useful thermonuclear density region ($n > 10^{13}$) with a power of the order of MW's using a reduced surface antenna system (1.5% of the total torus surface in the calculated example), an oscillating potential of 17kV being applied across it for an output of 1MW. The linear wave dissipation mechanisms considered at frequencies of ω(ci) and 2ω(ci) lead to a rapid heating of the ionic components. (FR)

12432 COMPUTER SIMULATION OF RADIOFREQUENCY CONFINEMENT OF A PLASMA. Hatch, A.J.; Shohet, J.L. (Argonne National Laboratory, Argonne, Illinois 60439). Phys. Fluids 17: No. 1, 232-239 (Jan 1974).

Computer simulation methods have been used to investigate the confinement of low-density plasmas in nonuniform rf electromagnetic fields. The basic problem is to obtain a numerical solution of the equations of motion of a single charged particle in two-dimensional cross sections of both confining and nonconfining electromagnetic field configurations in a resonant cavity. The occurrence of confinement in a quadrupole electric mode of a cavity is demonstrated and the ϕ quasipotential well theory of rf confinement is verified. The problem is then extended to large equal numbers of positively and negatively charged particles and the particle-in-cell method is used to include the effects of the self-consistent fields. The effects of finite initial temperature and of starting conditions are investigated. Confinement effects are observed in a quadrupole electric mode for initial temperatures corresponding to energies less than the depth of the ϕ well. (auth)

12433 TOROIDAL EQUILIBRIUM OF CURRENT-CARRYING PLASMAS. Yoshikawa, S. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08540). Phys. Fluids 17: No. 1, 178-180 (Jan 1974).

A general method was developed to determine a toroidal equilibrium of plasmas, once a cylindrically symmetric linear solution is known. Arbitrary current distribution can be treated. The application to an equilibrium calculation to toroidal E layer is also given. This azimuthally symmetric toroidal E layer has an advantage of stable configuration with poloidal magnetic field comparable to the toroidal magnetic field offering the possibility of high β toroidal plasma containment. (auth)

12434 LASER PLASMA HEATING IN A STRONG MAGNETIC FIELD. Martineau, J. (Centre de l'Énergie, Institut National de la Recherche Scientifique, Varennes, Québec, Canada). Phys. Fluids 17: No. 1, 131-136 (Jan 1974).

The heating of deuterium plasma created from solid granule ($\sim$ 100 μ diam; $\sim 10^{17}$ particles) confined by strong magnetic fields B_0 up to 1G is studied. Taking into account the inverse bremsstrahlung absorption process, an inhomogeneous hydrodynamic model is used to describe the plasma dynamics. The skin depth due to the diffusion of the magnetic field inside the plasma is calculated. Ohmic heating is taken into account. The magnetic body force for a diffusion plasma is given by $J \times B$ while for the infinite conductivity model the force is calculated from the magnetic pressure $B^2_0/2\mu_0$ on the plasma boundary. The efficiencies for CO_2 lasers and neodymium glass lasers are compared. It is important to feed energy slowly to obtain a high efficiency of incident laser energy to the plasma thermal energy. (auth)

12435 TRANSIENT FLOW AND HEATING IN A PINCHED PLASMA COLUMN. York, T.M.; Stover, E.K. (The Pennsylvania State University, University Park, Pennsylvania 16802). Phys. Fluids 17: No. 1, 127-130 (Jan 1974).

The axial flow and heating of an argon plasma in a pinched plasma column of a pulsed, linear z-pinch device was experimentally examined with a unique pressure sensing instrument capable of resolving mass flow properties. Transient ($\sim$ 5 μsec) axial pressure profiles identify periods of intense flow (4×10^4 m/sec) and heating ($T_i \sim$ 70 eV); mechanisms generating such effects were considered. (auth)

12436 NEOCLASSICAL DIFFUSION IN AN $l = 3$ STELLARATOR. Connor, J.W.; Hastie, R.J. (Culham Laboratory, United Kingdom Atomic Energy Authority, Abingdon, Berkshire, United Kingdom). Phys. Fluids 17: No. 1, 114-123 (Jan 1974).

Neoclassical diffusion in a stellarator is investigated in detail by introducing a consistent expansion in $\lambda^{1/3}$ (where λ is the inverse aspect ratio of the torus) for the magnetic fields and particle distribution function. As a result of the expansion, the various characteristic bounce and transit frequencies of the particle orbits appear in different orders, and various regimes of collision frequency (analogous to the "banana", and "plateau" regimes of the axisymmetric analysis) are considered separately. It is found that over most of the range of collision frequencies the diffusion is the same as that of an equivalent axisymmetric configuration with the sole role of the helical fields being that of supplying the rotational transform. At sufficiently low collision frequencies particle trapping in the helical field modulations becomes important and localized particle diffusion dominates. Expressions for the diffusion flux and ion heat flux are derived in this limit. (auth)

12437 ON THE THEORY OF ELECTROSTATIC CONFINEMENT OF PLASMAS WITH ION INJECTION. Hu, K.M.; Klevans, E.H. (Nuclear Engineering Department, The Pennsylvania State University, University Park, Pennsylvania 16802). Phys. Fluids 17: No. 1, 227-231 (Jan 1974).

A theoretical model of a spherical electrostatic confinement device with ion injection is presented. It is assumed that the potential inside

the accelerating cathode (inner wall) forms a virtual anode, and that a deep well for ion trapping exists inside this virtual anode. Particle distribution functions, composed of beams and trapped particles moving radially, are constructed which are consistent with the potential profile. The conditions needed for large ion trapping in the center are explicitly developed and their relationship to the fusion experiments of Hirsch are discussed. (auth)

12438 HOT-ELECTRON PLASMA BY ELECTRON CYCLOTRON-RESONANCE HEATING FOLLOWED BY MAGNETIC COMPRESSION. Alexeff, I.; Harris, J.G.; Murphy, C.; NamKung, W.; Saylors, M.; Pace, M. (University of Tennessee, Knoxville, Tennessee 37916); Ikegami, H.; Aihara, S.; Hosokawa, M.; Aikawa, H.; Okamura, S. Phys. Rev. Lett. 32: No. 19, 1035-1038 (13 May 1974).

A hot-electron plasma created by electron cyclotron-resonance heating ($T \simeq 50$ keV) has subsequently been superheated up to a factor of 12 using slow magnetic compression in mirror machines. (auth)

12439 DETERMINATION OF THE ELECTRON THERMAL CONDUCTIVITY ACROSS MAGNETIC SURFACES IN THE FM-1 SPHERATOR. Ejima, S.; Okabayashi, M.; Schmidt, J. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey, 08540). Phys. Rev. Lett. 32: No. 16, 872-875 (22 Apr 1974).

A new approach was taken to measure the electron thermal conductivity across magnetic surfaces by utilizing localized upper hybrid resonance heating. The electron thermal conductivity coefficient measured in the FM-1 spherator was increased with an increase of electron temperature for $T_e > 1$ eV. The dependence is similar to that of the particle diffusion coefficient. The absolute value was 10-20 times smaller than the Bohm coefficient. (auth)

12440 SHOCK WAVE HEATING TO FUSION TEMPERATURES. Gross, R. A. (Columbia Univ., New York). pp 72-79 of Recent Developments in Shock Tube Research. Stanford, CA; Stanford University Press (1973).

From 9th international Symposium; Stanford, CA (16 Jul 1973).

The Columbia electromagnetic shock tube is described, and recent research results obtained with this device are summarized. Shock speeds up to 4000 km/sec and plasma temperatures up to about 20,000,000°K have been obtained. The structure of plasma transverse shock waves, shock reflection from a wall, separation of the shock from the magnetic piston, radial variations in the flow, plasma-wall energy transfer, and computer simulation codes describing the plasma flow, are discussed. (auth)

12441 POWER AMPLIFICATION CONDITIONS FOR FUSION-REACTOR PLASMAS HEATED BY REACTING ION BEAMS. Furth, H.P.; Jassby, D.L. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08540). Phys. Rev. Lett. 32: No. 21, 1176-1179 (27 May 1974).

The plasma energy confinement time required to achieve a practically useful power amplification factor Q_E can be reduced substantially if the plasma is heated by an energetic ion beam that reacts with the bulk ions as it thermalizes. The contribution to Q_E arising from the beam-plasma fusion reactions can be maximized by maintaining the post-injection energy of the beam ions near an optimum value, for example, by means of slow magnetic compression. (auth)

12442 INJECTION OF HIGH-CURRENT RELATIVISTIC ELECTRON BEAMS INTO A TORUS. Meixel, G. D. Jr. Ithaca, NY; Cornell University (1973). 129p. University Microfilms Order No. 74-10,881.

Thesis (Ph. D.).

Initial injection experiments were performed by placing a planar field emission diode outside an aluminum torus and injecting the beam through a hole in the outer torus wall. Although the experiments carried out in this configuration with no externally applied magnetic field result in good propagation for one circuit around the torus, at least 95% of the beam is lost near the injector after that first circuit. The addition of externally applied, steady state magnetic fields do not reduce this large loss, in fact the addition of a toroidal magnetic field considerably reduces the amount of beam which travels once around the torus. External field shaping cathodes are developed and found to be successful in efficiency injecting a high-current beam into a 1 to 2 kilogauss magnetic field with subsequent propagation along the field lines. The dependence of injected beam position on the important parameters of beam current, external magnetic field strength and pressure in the beam propagation region are identified. Considerable flexibility in determining the degree of radial penetration of the beam is thereby achieved. By varying the experimental parameters the beam position may be adjusted from near the center of the cross-section, 10 gyro-radii from the point of injection, to just inside the wall. Calorimetric determination of the beam energy transferred down the one meter drift tube indicates that 30-50% of the energy available to the diode is successfully injected. A fast operating image converter streak camera with a total sweep time of 50 nanoseconds is used to photograph the propagation of the injected beam. Measurement of the beam head velocity (0.5c to 0.7c) indicates that this injection method which perturbs the confining magnetic field for only 50 ns can be used for confinement experiments in a torus with a circumference greater than 10 meters. (Diss. Abstr. Int., B)

12443 NEUTRAL PARTICLE ACCELERATOR UTILIZING RADIATION PRESSURE. Ashkin, A. (to Bell Telephone Labs., Inc.). US Patent 3,808,432. 30 Apr 1974. Filed date 3 Aug 1972. 14p.

Apparatus is described for generating plasmas at thermonuclear temperatures by employing radiation pressure to accelerate suitable reactant particles to a relative velocity at which their mutual collision can generate the required temperature of the nuclei within the time that one particle passes through the other. The orbital electrons and the nuclei will be heated essentially equally rapidly, so that, even with a relatively simple magnetic confinement field, electronic instabilities prior to thermonuclear fusion may be avoided. (Official Gazette)

12444 DYNAMIC METHODS FOR THE CONTAINMENT AND STABILIZATION OF HOT PLASMA. Osovets, S. M. (Inst. of Atomic Energy, Moscow). Usp. Fiz. Nauk; 112: No. 4, 637-683 (Apr 1974). (In Russian).

The present status of research on the containment and stabilization of hot plasma using high-frequency magnetic fields in the MHz range is reviewed. Theoretical examinations of plasma containment by hf systems of the moving wave type and the results of experiments made on this type installation were reported. Systems for the dynamic stabilization of plasma are then considered. The principles of the theory of dynamic stabilization of the z-pinch and experimental results are discussed. The experimental results are compared with theoretical assumptions and some general conclusions on the future development of this line of research are given. (tr-auth)

12445 POSITIONING AN IMPULSIVE, HIGH-BETA, HIGH-TEMPERATURE, DENSE, FUSION PLASMA PRODUCED IN A CURVED THETA-PINCH SECTOR. Cantrell, E. L.; Friedrich, O. M. Jr.; Dougal, A. A. (Univ. of Texas, Austin). pp 389-393 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

Experiments with a curved 30-kJ theta-pinch having a major toroidal radius of 1.25 meters and an aspect ratio of 250 are reported. Toroidal drift measurements indicate that plasmas having $\beta = 0.8$ and $T = 1.2$ keV are produced. A helical plasma excursion of approximately 1.10 is produced by a 70 kA, $l = 1$ helical current applied to external windings. An axisymmetric excursion of approximately 0.21 is produced by inserts in the theta-pinch coil. A vertical acceleration is observed as predicted by the analysis. Framing photographs at 50-nanosecond intervals indicate growth rates of the $m = 1$ instability of 0.5 to 200 MHz. Experimental parametric studies of the $m = 1$ growth rate give results which agree with theory. Experiments are reported for the modified helical equilibrium suggested by the analysis. An equilibrium in the horizontal plane is achieved, and the undesired vertical force is eliminated in accord with the analytic prediction. (auth)

12446 PETULA: A TOKAMAK BUILT FOR HIGH FREQUENCY HEATING. Frank, R.; Gauthier, A.; Lamboley, G. (EURATOM-CEA, Grenoble, France). pp 394-397 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

The PETULA device was especially built to study transit time magnetic pumping heating of a well confined plasma. A main technological difficulty was to build the vacuum vessel which is partly made of aluminum oxide. The solution which was chosen and some experimental results of experiments which were made to get information on outgassing properties of aluminum oxide in vacuum and facing on hydrogen plasma are described. (MOW)

12447 MECHANICAL ASPECTS OF THE ICRH APPARATUS ON THE ST MACHINE. Knutson, D. S.; Christie, R. S. (Princeton Univ., NJ). pp 485-488 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

The physical size and mechanical complexity of various parts of the Ion Cyclotron Resonance Heating (ICRH) apparatus on the ST

Tokamak machine are not immediately apparent from the electronics circuit diagram. 100 kV vacuum variable capacitors 8 inches in diameter and 16 inches long, housed in 24 inch diameter cans pressurized with sulphur hexafluoride are used in the matching network portions of the circuit. Special alumina ceramic housings, 12 inches in diameter and of intricate shapes, are used to hold and protect the load coils. The mechanical design of the load coils and matching network parts of the ICRH equipment and some of the problems encountered in their design and fabrication are described. (auth)

12448 TRITON: AN ELECTRON-BEAM PLASMA INTERACTION EXPERIMENT. Young, M. P.; Goldenbaum, G. C.; Ford, R. D. (Naval Research Lab., Washington, DC). pp 532-536 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

The TRITON experimental facility for the study of plasma heating by intense relativistic electron beams was built in late 1971 as part of the Naval Research Laboratory's Plasma Physics Program. The 4-m long, 15-cm diam plasma is created by a theta pinch energized by a 3-kJ bias capacitor bank operating at 20 kV. The base pressure of the plasma vacuum tube is about 10^{-5} torr; provisions are made to introduce known amounts of impurity gas into the system. The electron beam generator, which is in axial alignment with the theta coil, is fired after the plasma is formed. The generator comprises a 12-stage Marx generator, a Blumlein transmission line, and a diode. It gives 150 kA of 1.2-MV electrons for about 50 ns. A magnetic guide field, with a risetime of several milliseconds, is located at the accelerator diode so that the electrons are injected along magnetic field lines into the theta pinch plasma. The trigger system allows close time correlation between the theta-pinch capacitor banks, the electron beam generator, and the various diagnostic instruments. (auth)

12449 TRITON ELECTRON BEAM ACCELERATOR. Burton, J. K.; Condon, J. J.; Jevnager, M. D.; Lupton, W. H.; O'Connell, T. J. (Naval Research Lab., Washington, DC). pp 613-618 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

The TRITON accelerator was constructed to produce 150-kA beams of relativistic electrons for plasma heating experiments. The pulse generator is an 8-Ω, water-dielectric Blumlein circuit pulse charged by a 1-MV Marx generator. It is command triggered by four pressurized gas switches, and applies a negative 0.5 to 1.2-MV, 80-ns pulse to a carbon cathode in an AWRE style electron gun. The location of the switches in the outer transmission-line for accessibility of the trigger cables requires an unusual design for this generator. Pressurized trigatron switches were developed for this accelerator and measurements of the jitter in the simultaneity of their firing is presented. Effects of switch inductance and the complex circuit used are studied by a transient analysis which accurately predicts the output pulse. (auth)

Diagnostics

12450 (IPF-71-4) TEMPERATURE MEASUREMENTS IN ARGON PLASMAJETS BY A DIFFERENTIAL INTERFEROMETER. Hailer, H. (Stuttgart Univ. (TH) (F. R. Germany). Inst. fuer Plasmaforschung). 1971. 78p. (In German). INIS.

A commercial plasma burner is used as a plasma jet which was investigated by a differential interferometer consisting mainly of conventional optical equipments. The performance was tested and methods of data extraction are discussed. The device described can be used to determine the profile of the index of refraction in a plasmajet. (GE)

12451 (IPF-72-5) ELECTRO-OPTICAL SHUTTER FOR APERTURE TIMES OF 5×10^{-11} SEC. Strohwald, H. (Stuttgart Univ. (TH) (F. R. Germany). Inst. fuer Plasmaforschung). 1972. 63p. (In German). INIS.

The conditions necessary for the light source and experimental set-up for a short-time shutter, so that the exposure times $\Delta t < 10^{-9}$ s should be of any significance, were investigated. Then the limits for the shortest exposure time are shown for various image converters. Knowing the cause for this limit, an electro-optical shutter for an image converter has been set up. The smallest aperture time expected from the approximate calculation of 5×10^{-11} s was experimentally confirmed by measuring the switching pulse of the shutter. The shutter should be included with the optical diagnostic of intermittent plasmas and for the investigation of plasma instability. (GE)

12452 (IPF-73-3) FIBER-OPTICAL FABRY–PEROT RING ANALYZER WITH 15 MEASURING CHANNELS (TINTENFISCH). Bitzenberger, B.; Doebele, H. F.; Hunl, J. P. R. (Stuttgart Univ. (TH) (F. R. Germany). Inst. fuer Plasmaforschung). 1973. 17p. (In German). INIS.

General properties, construction, and manufacture of glass fiber interferometers together with the test measurements (transmission, radii series of the circular zones) are described in detail. (GE)

12453 (LRP-78/74) DIAMAGNETIC MEASUREMENTS OF A THETA PINCH. Keller, R. (Ecole Polytechnique Federale, Lausanne (Switzerland)). Mar 1974. 34p. (In French). Dep. NTIS (US Sales Only) $4.75.

The formative and adiabatic phase of a theta pinch are investigated by diamagnetic probe measurements. The radial implosion is interpreted with the aid of an analytic shock wave model which enables the determination of the initial ionization and the mass collection. Measurements of temperature and mean beta value during the adiabatic compression are made for different deuterium pressures and preionization conditions. (auth)

12454 MEASURING THE AVERAGE ION MASS IN A GAS-DISCHARGE WITH A SIMPLE LANGMUIR PROBE. Geissler, K.H. (Aeronomy Laboratory, National Oceanic and Atmospheric Administration, Boulder, Colorado 80302). Rev. Sci. Instrum. 45: No. 4, 604-605 (Apr 1974).

The orbital theory of current-collection of a cylindrical Langmuir probes is applied to determine the average ion mass in a discharge. The analytical derivations are supplemented by experimental results. Applications are discussed. (auth)

12455 STABILIZED INTERFEROMETER MODIFICATIONS. Cummins, W.F. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). Rev. Sci. Instrum. 45: No. 4, 600-601 (Apr 1974).

The stabilized 70 GHz interferometer used for plasma density measurements on the 2XII experiment has been modified to increase its stability, linearity and dynamic range. (auth)

12456 CHARACTERISTICS OF THE USE OF A ROGOWSKI LOOP FOR MEASURING STEADY CURRENTS IN PLASMA. Belinskii, V.N.; Grishin, S.D.; Orlov, R.V.; Ogorodnikov, S.N. (Moscow). High Temp. 11: No. 1, 34-38 (Sept 1973).

A method measuring the distribution of steady currents in plasma based on the use of a movable Rogowski loop is investigated. The essence of the method and its characteristic features are presented, the area of use and effect of technical characteristics of the transmitter on the measurement errors are evaluated, and the accuracy of the method is determined. The results of investigating the current distribution in a plasma jet of accelerators with external and self-magnetic fields are presented. (auth)

12457 DETERMINATION OF THE ELECTRON TEMPERATURE IN A PLASMA FROM THE COLLISIONLESS ABSORPTION OF AN EXTRAORDINARY WAVE. Skibenko, A.I. (Physicotechnical Institute, Academy of Sciences of the Ukrainian SSR). High Temp. 11: No. 1, 5-11 (Sept 1973).

The synchrotron absorption of an extraordinary wave propagating in a plasma along a homogeneous magnetic field is investigated as a function of the electron temperature for different values of the electron density and the strength of the external magnetic field. It is shown that one can determine the temperature of a hot plasma from the ceasing of the propagation of the extraordinary wave if the density and the magnetic field strength are known. The factors determining the accuracy of the method are analyzed. (auth)

12458 ARC PLASMA DIAGNOSTIC TECHNIQUES. Gol'dfarb, V.M. (A. I. Gertsen Leningrad State Pedagogical Institute). High Temp. 11: No. 1, 150-161 (Sept 1973).

Modern arc plasma diagnostic techniques are reviewed. Various methods of determining the parameters of electric arc plasmas are discussed. (auth)

12459 COLLECTIVE SCATTERING OF LASER RADIATION IN A PLASMA. Aksenov, V.V.; Eroshenko, V.M.; Mushinskii, A.A.; Pyatnitskii, L.N. (G. M. Krzhizhanovskii Energy Institute). High Temp. 11: No. 1, 1-4 (Sept 1973).

The plasma parameters in a plasmatron jet were determined by scattering laser radiation on electrons. The method for measuring the scattering spectrum during a single laser pulse is described. It was shown that under the conditions of a low-temperature plasma at atmospheric pressure the scattering spectrum is collective in nature. (auth)

12460 VIRTUAL EXCITER OF ION-ACOUSTIC WAVES IN AN EXTERNAL MAGNETIC FIELD. Alexeff, I.; Hirose, A. (University of Tennessee, Knoxville, Tennessee 37916). Phys. Fluids 17: No. 1, 256-257 (Jan 1974).

When a pulse disturbance is applied to a wire in a magnetized plasma, a receiving probe exhibits two ion-acoustic disturbances, one depends only on $d_\perp$, the cross-field distance, and the other on the actual distance, $(d^2_\parallel + d^2_\perp)^{1/2}$, between the exciter and the receiver. (auth)

12461 DIAGNOSTIC MEASUREMENTS OF CURRENTS AND MAGNETIC FIELDS IN AXISYMMETRIC PLASMAS. Hartman, C.W.; Hooper, E.B. Jr. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). Phys. Fluids 17: No. 1, 269-270 (Jan 1974).

The azimuthal current and magnetic flux in an axisymmetric torus or mirror are related to the (anisotropic) plasma pressure. Measurements by a Rogowski loop and a flux loop can be used to determine the spatially averaged components of pressure along and across the magnetic field. (auth)

12462 SWEEP GENERATOR FOR A DOUBLE IMAGE CONVERTER. Kondrat'ev, E. L.; Semenov, A. A. (Moscow State Univ.). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 16: No. 6, 1718-1719(1973).

Translated from Prib. Tekh. Eksp.; 16: No. 6, 92-93(1973).

A transistor generator is described which produces a paraphase voltage having a triangular shape with an amplitude of 900 V and length of 2 to 20 μsec across a load of 100 pF. The nonlinearity in the working portion of the sawtooth voltage is ~5% for a slope of the starting-pulse top equal to 3%. (auth)

12463 NONLINEAR SCATTERING DIPOLE FOR ELECTROMAGNETIC FIELD MEASUREMENTS IN PLASMAS. Stenzel, R.L. (TRW Systems Group, Redondo Beach, California 90278). Rev. Sci. Instrum. 45: No. 5, 626-630 (May 1974).

Absolute electric field measurements of a 2 GHz electromagnetic wave in a nonuniform plasma are described. A remote measurement technique with minimum perturbations is used in which the information is obtained at the launching antenna from the backscattered signal of a small movable dipole in the radiation field. The weak scattering signal of the test dipole is discriminated against reflections from metallic walls and the plasma cutoff layer by introducing a small frequency shift ($\Delta\omega/\omega \simeq 10^{-3}$) at the dipole. The dipole contains a passive nonlinear reactive element (varactor diode) which generates multiple sidebands when irradiated with two frequencies. The nonlinear behavior of the sidebands is used to obtain an absolute calibration for the electric field strength at the dipole. Mismatch effects due to the density dependent dipole radiation resistance are minimized by terminating the dipole with a high impedance. (auth)

12464 A HEAT-RESISTANT MAGNETIC PROBE FOR THE INVESTIGATION OF HIGH-PRESSURE HEAVY-CURRENT PULSED DISCHARGES. Petrenko, V.I.; Samoilov, V.P.; Mitin, R.V. (Physicotechnical Institute, Academy of the Ukrainian SSR). High Temp. 11: No. 4, 788-790 (Mar 1974).

The design of a magnetic probe with heat shielding of glass textolite capable of measurements in heavy-current (30–80 kA) pulsed discharges at superhigh pressures (up to 400 atm or more) that can withstand up to 100 pulsed discharges without damage is described. (CES)

12465 DETERMINATION OF THE TRANSPARENCY OF AN OPTICALLY NONTHICK PLASMA USING THE INTERCAVITY METHOD. Burakov, V.S.; Zhukovskii, V.V.; Naumenkov, P.A.; Nechaev, S.V.; Stavrov, A.A. (Institute of Physics, Academy of Sciences of the Belorussian SSR). High Temp. 11: No. 4, 814-816 (Mar 1974).

The intercavity method was used to investigate the absorptivity of an open-type plasma at a lasing wavelength of 1153 nm, including an experimental estimate of the sensitivity of the method, an estimate of the contribution of possible thermal distortions of the cavity, and development of measurement techniques for investigating pulsed plasma models. The plasma sources used were a dc arc and an electric discharge in a textolite capillary with sodium salts added to its walls. (CES)

12466 SCATTERING OF LASER RADIATION BY A LOW-TEMPERATURE PLASMA. Zhuravlev, V.A.; Petrov, G.D.; Yurchuk, E.F. (All-Union Scientific-Research Institute for Physicotechnical and Radiotechnical Measurements). High Temp. 11: No. 4, 783-784 (Mar 1974).

The temperature and concentration of electrons and ions can be found from the directional diagram of optical radiation scattered by a plasma. Up till now, however, the indicatrix of scattered optical radiation in a plasma has not been experimentally investigated. In this paper the indicatrix of a powerful pulsed ruby laser scattered by a carbon arc plasma is determined. (AIP)

12467 APPARATUS FOR MEASURING LOCAL PARAMETERS OF A PLASMA STREAM USING A HOT-WIRE ANEMOMETER PROBE. Bugrova, A.I.; Versotskii, V.S.; Zavarzina, I.F.; Krasnenkov, M.A.; Kubarev, Y.V. (Moscow Institute of Radio Technology, Electronics, and Automation). High Temp. 11: No. 4, 806-808 (Mar 1974).

We describe an apparatus that enables us to obtain information on the temperature and the density of electrons, ions, and neutrals and also to determine the directed velocity of ions and of neutrals. (AIP)

12468 A MULTI-ION MASS SPECTROMETER. van Hulsteyn, D.B.; Hearrell, L.R. (Department of Electrical Engineering, The University of Texas at Austin, Austin, Texas 78712). Rev. Sci. Instrum. 45: No. 6, 819-824 (June 1974).

A multi-ion mass spectrometer has been developed which allows the simultaneous measurement of the velocity distributions of each of the several ion species contained in a burst of streaming plasma. The device utilizes parallel dc magnetic and electric fields to separate the ions according to their charge-to-mass ratios and collects the ions on sets of discrete targets arranged in linear rows. A COS/MOS digital integrated circuit assembly is used to scan and record, in sequence, the output of the integrators connected to each target. The basic design features, circuitry, and test results are presented. (auth)

12469 TWO-WAVELENGTH HOLOGRAPHIC INTERFEROMETRY OF EXPLODING WIRES. Seftor, J.L. (Air Force Weapons Laboratory, Kirtland Air Force Base, New Mexico 87117). J. Appl. Phys. 45: No. 7, 2903-2906 (July 1974).

A pulsed ruby laser, equipped with a frequency-doubling crystal, has been used to make two-wavelength holographic interferograms of exploding-wire events. For selected times after initiation, estimates of electron density have been made by noting the dependence of the phase index of refraction on wavelength. Once the electron contribution to refractivity is known, the heavy-particle contribution to refractivity can be isolated. With an estimate of specific refractivity from oscillator strengths, the concentration of heavier particles has been calculated. (auth)

12470 INJECTION OF SMALL MACROSCOPIC PARTICLES IN PLASMA AS A DIAGNOSTIC TECHNIQUE. Anestos, T. C. Urbana, IL; University of Illinois (1973). 86p. University Microfilms Order No. 74-11,933.

Thesis (Ph. D.).

A method for the determination of the electron temperature of a plasma by measuring the charge acquired by a small spherical macroscopic particle of the order of 25 micron diameter as it travels through the plasma is investigated. The particles are generated by the electromechanical breakup of a liquid jet. The plasma is created inside a cylindrical magnetron, which utilizes crossed electric and magnetic fields. Since the electrons are usually much faster than the ions, the particles acquire a negative equilibrium charge. This charge is determined by measuring the deflection of the particles in an electric field. A theoretical relation between the electron temperature and the particle charge is derived which allows the determination of the electron temperature after the charge of the particle is measured experimentally. The theoretical calculations are simplified by the fact that the particle radius is much smaller than the Debye length and the Larmor radius of the electrons. Measurements of the electron temperature in argon and helium plasmas are made and comparisons with Langmuir probe measurements show good agreement. Injection of particles in plasma as a diagnostic technique can be particularly useful in plasmas of high temperature and density where a conventional Langmuir probe could not be used. (Diss. Abstr. Int., B)

12471 LOW-NOISE DATA COLLECTION SYSTEM FOR THE THOMSON SCATTERING DIAGNOSTIC APPARATUS ON ORMAK. Dyer, G. R.; Murakami, M. (Oak Ridge National Lab., TN). pp 403-405 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

An automated data collection system that was designed and built for the ORMAK Thomson scattering apparatus is described. The system uses both gated photomultipliers and gated integrators; advantages of this approach are discussed. Four electron temperature and electron density measurements can be made during each plasma discharge, with measurements spaced as closely as one millisecond apart. Data are automatically digitized and stored in a computer for processing and display. (auth)

12472 ORMAK DATA HANDLING. Francis, J. E.; Wing, W. R.; Yonts, O. C. (Oak Ridge National Lab., TN). pp 496-497 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

With the use of small, relatively inexpensive computers, data acquisition and analysis for the ORMAK experiment is being greatly expanded. Since ORMAK is a pulsed machine, data must be acquired at a very high peak rate for a relatively short time. To help circumvent this timing restriction one PDP-12 and two PDP 8/E's have been assigned to acquire data. After a shot the data are transferred to the PDP-12 for storage. The role of each computer during a shot is described. (auth)

12473 DIRECT READOUT, SELF-CALIBRATING, MULTI-RADIAN MICROWAVE PHASE MEASURING SYSTEM. Ernst, W. P. (Princeton Univ., NJ). pp 654-657 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

A microwave phase measuring system is described that is capable of providing phase change vs time data with a self-calibrating feature to indicate the number of 2π radians of phase change. A combination of standard phase measuring techniques is used to provide the required information. The microwave bridge network and modulation scheme provide the phase information signals for: (1) A phase comparator that measures the time difference between zero crossings of the signal on each channel and converts this time difference into the number of 2π radians of phase change, which is ultimately displayed as brightening spots on the oscilloscope display of the discriminator-integrator output. (2) A frequency discriminator-integrator circuit that converts the equivalent frequency change of a phase modulated signal into an output voltage that is directly proportional to the instantaneous phase change. Phase change rates of up to 2π radians per 100 microseconds may be handled. The system has been operated at a frequency of 70 GHz for use on Tokamak-type plasma experimental devices. (auth)

Kinetics (General)

Refer also to abstract 13614.

12474 (IPP-Libr-36) QUARTERLY TITLE LIST, OCTOBER–DECEMBER 1973. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (F. R. Germany)). 1973. 31p. INIS.

The abstracts or, in some cases, only the titles of 10 laboratory reports, 18 publications, 10 articles submitted for publication, and 40 lectures held at various meetings are presented. (HK)

12475 COMMENTS ON "ELECTROSTATIC OSCILLATIONS IN PLASMA WITH CUTOFF DISTRIBUTIONS". Kent, G. (Department of Electrical Engineering, Syracuse University, Syracuse, New York 13210). Phys. Fluids 17: No. 1, 271-272 (Jan 1974).

We discuss the recent paper on computer studies of electrostatic oscillations in a plasma. (AIP)

12476 REPLY TO COMMENTS BY GORDON KENT. Canosa, J. (IBM Scientific Center, Palo Alto, California 94304). Phys. Fluids 17: No. 1, 273-273 (Jan 1974).

We reply to the comments on our recent paper on computer studies of electrostatic oscillations in a plasma. (AIP)

12477 ANOMALIES IN THE SCATTERED LASER LIGHT SPECTRA OF A HIGH CURRENT CARBON ARC PLASMA. Churchland, M. T.; Nodwell, R. A. (Univ. of British Columbia, Vancouver). Can. J. Phys.; 52: No. 7, 655-663(1 Apr 1974).

The scattered light spectra of a high current carbon arc plasma were studied. The temperature and density of the arc column were mapped using conventional scattering techniques. Small enhancements in the scattered light spectra were found at several wavelength shifts, including the shift corresponding to the plasma frequency. The dispersion relation of the anomalous waves was studied as a function of the plasma parameters. A theoretical model was constructed with a dispersion relation similar to that observed experimentally. (auth)

12478 COMPRESSIBLE JEFFERY–HAMEL FLOW OF A PLASMA. Wilhelm, H. E. (Colorado State Univ., Fort Collins). Z. Naturforsch.; 28a: No. 10, 1591-1602(Oct 1973).

A similarity transformation is given, which reduces the partial, nonlinear differential equations describing a compressible, polytropic plasma flow across an azimuthal magnetic field in a duct with plane inclined walls to an ordinary nonlinear differential equation of second order. The latter is solved rigorously in terms of a hyperelliptic integral. The form of the plasma flow fields in pure outflows (diffuser) is discussed analytically in dependence of the Reynolds (R) and Hartmann (H) numbers and the polytropic coefficient (γ) for given duct angles theta. The realizable Mach numbers are shown to be eigenvalues of the nonlinear boundary-value problem, $M = M_\chi$ (R, H, γ, theta). The mann number H_c defined by $H_c^2 = [2(\gamma-1)/(\gamma+1)]R + [2\gamma/(\gamma+1)]^2$. Some of the eigenvalues M_χ are calculated and the associated velocity profiles are represented graphically for prescribed flow parameters. (GE)

12479 INDUCTIVE PLASMA ACCELERATION WITH NONSINUSOIDAL ELECTROMAGNETIC STANDING WAVES. Koehne, R.; Meert, A. (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt eV, Stuttgart). Z. Naturforsch.; 29a: No. 1, 45-50(Jan 1974). (In German).

Measurements were carried out on this system. Numerical calculations were made for the plasma acceleration process and compared with the experimental values of the velocity. The theory as well as the advantage of the proposed system is verified by the results. (GE)

12480 FREQUENCY SHIFTS AND ANOMALOUS RESISTIVITY OF TURBULENT PLASMAS IN EXTERNAL ELECTRIC AND MAGNETIC FIELDS. Spatschek, K. H.; Shukla, P. K. (Univ., Bochum, Ger.). Z. Phys.; 267: No. 3, 193-200(Apr 1974).

Taking into account the modified orbits of plasma particles due to constant external electric and magnetic fields, a general expression for the velocity space diffusion tensor of a turbulent plasma is derived. The nonlinear frequency shift and the anomalous resistivity in the presence of external fields are calculated. It is shown that the effect of a strong external electric field on the frequency shift is to reduce its magnitude. Furthermore, the dependence of the anomalous resistivity on the external magnetic field is obtained. (GE)

12481 ANODE SURFACE RADIANCE FROM MICROSECOND VACUUM ARCS. Grissom, J.T.; Newton, J.C. (Sandia Laboratories, Albuquerque, New Mexico 87115). J. Appl. Phys. 45: No. 7, 2885-2894 (July 1974).

Measurements of anode surface radiance as a function of time for microsecond-duration vacuum arcs have been performed using an infrared-sensitive solid-state detector. Anode surface temperatures have been inferred from the measured radiance values using information concerning the surface spectral emittance. Particular attention has been given to the measurement of anode spot temperatures as a function of time. The anode materials investigated are Al, Cu, and Kovar. In addition, surface temperatures due to plasma heating of Al_2O_3 (alumina) and BeO (beryllia) ceramics surrounding the active anode area have been determined. Values of the average anode current density ranged from 6×10^3 to 5×10^4 A/cm^2, with arc current pulse lengths of 1–12 μsec. Anode spot temperatures between 2600 and 3300 °C for Cu, and between 2000 and 2400°C for Al were observed. The maximum surface temperatures of the ceramic insulators were between 2900 and 3500 °C for Al_2O_3 and between 2000 and 2300 °C for BeO. Calculations based on an integral equation solution to the heat-flow equation suggest that the input power density to the surface falls between 10^6 and 10^7 W/cm^2 for Al, Cu, Al_2O_3, and BeO. Based on these values, estimates of the anode spot current density for Al and Cu fall between 10^5 and 10^6 A/cm^2. (auth)

12482 ADVANCES IN PLASMA PHYSICS. Volume 5. Simon, A.; Thompson, W. B. (eds.). New York; John Wiley and Sons, Inc. (1974). 301p.

Selected papers of the Conference on Plasma Theory held in Kiev, USSR, in October 1971 are included. This volume contains all of the review talks, a number of specially revised rapporteurs talks, and several of the original reports given at the conference. (MOW)

12483 IMPUL'SNYI TOK I RELAKSATSIYA V GAZE. (Pulse Current and Relaxation in Gases). Malkin, O. A. Moscow; Atomizdat (1974). 280p.

This book describes the results of an experimental study of elementary processes in a quasistationary and relaxed gas-discharge plasma during strong and weak ionization. In the weakly-ionized plasma a study is made of the nonequilibrium function of electron energy distribution and its effect on the rate coefficients of inelastic processes and of the transfer process. The results are compared with those calculated by theory. The nature of the basic elementary processes is explained with participation of molecular ions in the inert gas. In the strongly-ionized plasma a study is made of the conditions of realizing partial and total, local thermodynamic equilibrium. The inadequacy of approximate criteria of equilibrium by Grim and others is pointed out. Experimental data are compared with data calculated from the approximate MDP-theory developed

by L. M. Biberman, V. S. Vorob'ev and I. T. Yakubov. As a result of studying the breakdown of a highly-ionized plasma, temperature dependencies of generalized recombination coefficients were obtained for the hydrogen-like ions of hydrogen and helium. The general picture of elementary processes in a low-temperature plasma is described for various degrees of ionization. (SJR)

12484 HOOKE AND JEEVES METHOD APPLIED TO THE STUDY OF THE FOCUSING PROPERTIES OF CHARGED PARTICLES IN AN AXIALLY SYMMETRIC MAGNETIC FIELD. Greenaway, A. H.; Michelson, D. (Brunel Univ., London). J. Phys., D (London); 7: No. 6, 793-804(11 Apr 1974).

The focusing properties of charged particles in combined spheroidal and uniform fields were studied using computational methods. It is shown that by choosing a suitable criterion the focusing may be readily optimized. The above fields were chosen because of the existing information on the solution space, but it is shown that the method can be easily extended to other field forms. Some preliminary investigations were made on the above fields together with a "monopole". (auth)

Kinetics (Experimental)

12485 (IPF-72-3) ION DIFFUSION IN ELECTRODELESS BOUNDARY LAYERS OF A FOCUSLESS DISCHARGE PERPENDICULAR TO A FLOWING PLASMA. Forster, B. F. (Stuttgart Univ. (TH) (F.R. Germany). Inst. fuer Plasmaforschung). 1972. 103p. (In German). INIS.

The discharge between electrodes which are situated parallel to a laminar flowing nitrogen plasma is investigated at a temperature of about 6,000 K and at a pressure of 1 atmosphere. At low currents a saturation occurs whereas at heavy currents two types of discharge occur: rising current at constant voltage and decreasing current at higher currents and relatively low voltages. The establishment of a bent arc and restricted spots at the electrodes is determined by the schlieren method. The saturation current increases with increasing gas temperature. Thermionic electron emission from tungsten electrodes is excluded by pyrometric determination of electrode temperature. Assuming constant temperature in the discharge regime, the current transport equations are integrated for 3 components (electrons, ion, neutral particles) at low ionization degrees. The current carrier density at the border, at saturation current and the low voltage characteristic are solved analytically. It is shown by means of the energy equation for the electron gas that the observed high values for the electron temperature are due to the strong coupling between electron temperature and vibrational temperature of N_2. (GE)

12486 HELICAL PLASMA STRUCTURE OBSERVED IN A HARD-CORE THETA PINCH. Düchs, D.F.; Dixon, R.H.; Elton, R.C. (Naval Research Laboratory, Washington, D. C. 20375). Phys. Fluids 17: No. 1, 124-126 (Jan 1974).

Through the addition of an axial current-carrying conductor (hard core), helical fields and magnetic shear have been added to the elongated toroidal plasma generated in a θ-pinch device operated with antiparallel bias field. Two-dimensional (r, z) photographs indicate the presence, from the beginning of the discharge, of a persistent luminous helical structure imbedded in the annular plasma. (auth)

12487 TOROIDAL DRIFT OF A COLLISIONLESS PLASMA. Ejima, S.; Marshall, T.C.; Schlesinger, S.P. (Plasma Laboratory, Columbia University, New York, New York 10027). Phys. Fluids 17: No. 1, 163-169 (Jan 1974).

The toroidal drift of a collisionless plasma flowing along a curved magnetic field has been directly observed. The experiment was done using a low density plasma generated in a small single-ended Q machine. The magnetic lines were bent into an arc of a circle with curvature adjustable by additional magnetic windings, designed for smooth line curvature with the aid of a stereoscopic computer-graphics device; the magnetic geometry was also determined by a weak electron beam. The polarization field in the plasma was short-circuited by the presence of the hot ionizer which terminated one end of the plasma. The toroidal drift was observed experimentally by a movable battery of 45 probe wires mounted in an insulator which terminated the other end of the plasma. The plasma potential and plasma density were measured with this and displayed quantitatively using a fast analog-digital data printer. The experimental data correlated satisfactorily with a two-fluid theory in which the curvature drift was modeled by an effective gravitational force. (auth)

12488 RADIATIVE-AUGER TRANSITIONS IN SOFT-x-RAY PLASMA EMISSION. Elton, R.C.; Palumbo, L.J. (Naval Research Laboratory, Washington, D. C. 20375). Phys. Rev. A 9: No. 5, 1873-1884 (May 1974).

A broad, prominent emission blend is observed between 15 and 22 Å from a plasma produced in a θ-pinch deuterium discharge seeded with neon. The occurrence of this feature is associated with radiative-Auger-transition channels in various intermediate ion species, following the creation of short-lived 1s-orbit vacancies by the dielectronic capture of free electrons. The calculated blended spectrum from several stages of ionization agrees with the measured contour. A similar feature is detected near 27 Å with oxygen seeding. The measured intensities and shapes indicate that $2\ ^1S \rightarrow 1\ ^1S$ two-photon spontaneous emission in helium-like ions is negligible for existing plasma conditions. (auth)

12489 MEASUREMENT OF PLASMA DIELECTRIC CONSTANT IN SHOCK TUBE. Tusnov, Yu. I. (Moscow Inst. of Radiotechnology, Electronics, and Automation). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 2, 27-31(1974). (In Russian).

This study reports on measurements of the electrical characteristics of a plasma in waveguide and coaxial shock tubes over the frequency range of 200 to 7300 megahertz. (SJR)

Kinetics (Theoretical)

Refer also to abstracts 12440 and 13864.

12490 (IPPJ-167) PARAMAGNETIC CONFIGURATION WITH ABSOLUTE MINIMUM-B PROPERTY. Ikuta, K. (Nagoya Univ. (Japan). Inst. of Plasma Physics). Jul 1973. 8p. INIS.

The equilibrium configuration is calculated including the beam–plasma interaction. This type of equilibrium allows the paramagnetic configuration with absolute minimum-B property. Configuration with both high shear and absolute minimum-B is possible without external guide field. (auth)

12491 (IPPJ-169) NONADIABATIC MOTION OF CHARGED PARTICLE IN AN INHOMOGENEOUS MAGNETIC FIELD. Horikoshi, G.; Toyama, H.; Kuroda, T. (Nagoya Univ. (Japan). Inst. of Plasma Physics). Jul 1973. 18p. INIS.

A new analytic expression is obtained in a differential form for nonadiabatic change of magnetic moment μ of a charged particle in an inhomogeneous magnetic field. The expression gives a picture easier to be understood than the past. The results agree well with numerical calculations which were made previously. (auth)

12492 EFFECT OF THE CLUSTER INTEGRALS ON THREE PARTICLES ON THE CALCULATED ELECTRON DENSITY OF A HYDROGEN PLASMA. McIntyre, R.G.; Bruce, R.E. (University of Texas at El Paso, El Paso, Texas 79968). J. Chem. Phys. 60: No. 9, 3392-3395 (1 May 1974).

The effect of the calculation of the cluster integrals on three particles is analyzed and evaluated for a hydrogen plasma where a pairwise-additive hard sphere–Coulomb potential is assumed. The Mayer cluster integral method was used to calculate the Helmholtz free energy which was then applied to the calculation of the electron number density through an iterative technique using a corrected Saha equation. It is seen that the three particle integrals provide a substantial correction to the calculations in the low energy–high density region of the hydrogen plasma. (auth)

12493 SOME MAGNETOHYDRODYNAMIC FREE BOUNDARY EQUILIBRIA. Stevens, D.C. (Courant Institute of Mathematical Sciences, New York University, New York, New York 10012). Phys. Fluids 17: No. 1, 222-226 (Jan 1974).

An iterative computational method of solving certain axially symmetric free boundary problems is presented. At each step of the iteration, the boundary is displaced closer to the equilibrium position by an amount proportional to the unbalanced force acting on the boundary. The method is used to find the behavior of a tokamak plasma in adiabatic compression under a uniform vertical field. Also, the Princeton adiabatic toroidal compressor is simulated and a comparison of the results is given. (auth)

12494 THEORY OF TWO-DIMENSIONAL TURBULENCE. Dupree, T.H. (Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). Phys. Fluids 17: No. 1, 100-109 (Jan 1974).

The two-dimensional Navier-Stokes equation and the drift approximation to the Vlasov equation are equivalent. An analytical theory of the turbulent state of this system is developed which contains no ad hoc assumptions. The theory is not strictly valid for the largest eddies and in the inertial range is restricted to large Reynolds numbers. A vorticity flow to large wavenumbers and an energy flow to small wavenumbers is predicted. In the inertial range the theory has a similarity solution whose spectrum agrees with that obtained from dimensional arguments. Diffusion coefficients are derived and the extension to shear turbulence and more general plasma turbulence is discussed. (auth)

12495 ELECTRIC FIELD CORRELATIONS IN THE GUIDING-CENTER PLASMA. Joyce, G.; Montgomery, D.; Emery, M. (Department of Physics and Astronomy, The University of Iowa, Iowa City, Iowa 52242). Phys. Fluids 17: No. 1, 110-113 (Jan 1974).

Electric field autocorrelations for the two-dimensional electrostatic guiding-center plasma are calculated numerically. It is concluded that the autocorrelation, averaged over a thermal equilibrium ensemble, is damped in an approximately exponential fashion, as predicted by Taylor and McNamara. Oscillatory behavior of the type predicted by Taylor and Thompson is not observed. (auth)

12496 GENERALIZATION OF THE THEORY OF ICHIMARU. II. PARTICLE CORRELATIONS IN A CLASSICAL ONE-COMPONENT PLASMA. Jain, M.; Jain, S.C. (Physics Department, Rajasthan University, Jaipur-302004, India). Phys. Rev. A 9: No. 4, 1733-1739 (Apr 1974).

In a previous paper the present authors have formulated a generalized theory of the dielectric function of an interacting electron liquid which was found to yield an almost exact satisfaction of the compressibility sum rule and fair results for the pair-correlation function g(r). In the present paper we attempt to apply this generalized procedure to the case of a classical one-component plasma. Calculations are performed for the various physical quantities such as the pair-correlation function, compressibility, correlation energy, etc., and a substantial improvement upon the Debye-Huckel theory (classical random-phase approximation) is observed. The present study gives a remarkable improvement in the satisfaction of the compressibility sum rule in comparison to both the theory of Singwi et al. and of Ichimaru. The values of g(r) show a close resemblance to the previous estimates. (auth)

12497 USEFUL SIMPLE RECURSION FORMULA TO ACCOUNT FOR INELASTIC COLLISION EFFECTS ON THE ELECTRON DISTRIBUTION IN A PLASMA. Claassen, H. A. (Kernforschungsanlage, Juelich, Ger.). Z. Naturforsch.; 28a: No. 12, 1875-1884 (Dec 1973).

The competitive effects of inelastic electron–atom collisions and electron–electron interactions on a sufficiently isotropic electron distribution are considered for a low temperature monatomic plasma. It is presupposed that unbalanced collisional transitions between ground state and resonance level of the plasma atoms are the dominant disturbance effect on the electron distribution. The unbalance is assumed to be due to resonance radiation escape and excitation diffusion. An analytical solution, which permits the calculation of the electron distribution even well above the ionization energy of the atomic ground state, is presented. In particular, it is demonstrated that due to the rapid decrease of the Coulomb cross section with increasing electron energy, the solution for the high energy tail of the electron distribution can be related to its form at lower energies by a simple recursion formula. The latter enables an easy computation of the ionization coefficients even for the lowest atomic energy levels. The analytical solution and its high energy approximation are numerically evaluated for the example of a low temperature, low pressure cesium plasma. (GE)

Production

Refer also to abstract 12443.

12498 (Juel-1025-PP) PRODUCTION OF HIGHLY IONIZED PLASMA AT LOW GAS PRESSURES. Chandrakar, K. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Inst. fuer Plasmaphysik). Nov 1973. 15p. INIS.

5 figs.; 7 refs. With abstract.

A fully ionized plasma was produced in a quartz tube with two plane parallel electrodes 30 cm apart and 8 cm in diameter at p approximately 10^{-4} torr in hydrogen by first starting a sliding spark between the cathode and an auxiliary electrode near the cathode and then applying the main voltage pulse. The spatial and temporal growth of the discharge were studied by observing 8 mm microwave interferograms at three points along the length of the discharge tube and by photographing the discharge. In hydrogen the time delay between the application of the main voltage and the starting of the discharge current remained nearly constant at $p < 10^{-4}$ torr and then decreased with increasing p. Similar results were obtained with helium and neon. The plasma instabilities produced in the discharge column can be reduced as well as the ion density increased by externally superimposing a suitable magnetic field. (AH)

12499 PLASMA SOURCE FOR PRODUCING A LARGE DIAMETER PLASMA COLUMN IN A MAGNETIC FIELD. Yatsu, K.; Uehara, K.; Hagiwara, S.; Kojima, S. (Department of Applied Physics, Tokyo University of Education, Otsuka, Tokyo, Japan). Rev. Sci. Instrum. 45: No. 4, 570-571 (Apr 1974).

A new discharge-type plasma source with an average minimum B magnetic field has been developed. The plasma source produces a fairly quiescent plasma column of about 4 cm diam with almost flat topped density distribution. (auth)

12500 INTENSITY ANOMALIES IN THE EXTREME VUV SPECTRUM OF Al^{+3} OBTAINED IN A LASER-PRODUCED PLASMA. Valero, F.P.J. (Ames Research Center, National Aeronautics and Space Administration, Moffett Field, California 94035). Appl. Phys. Lett. 25: No. 1, 64-66 (1 July 1974).

The results of experiments performed to check the possibility of stimulated emission in the extreme vacuum ultraviolet (VUV) by an Al^{+3} laser-generated plasma are reported. It is concluded that the spectral line intensity anomalies previously observed are not due to population inversion. (auth)

12501 INFLUENCE OF LASER RADIATION ON THE COLLISIONAL-RADIATIVE RECOMBINATION AND IONIZATION COEFFICIENTS. Drawin, H. W.; Emard, F. (EURATOM-CEA, Fontenay-aux-Roses, France). Z. Phys.; 266: No. 4, 257-264 (Feb 1974).

From Europhysics study conference on atomic and molecular physics of ionized gases; Versailles, France (3 Apr 1974).

It is shown that irradiation of a plasma by a laser beam lowers the collisional-radiative coefficient for recombination (α) and increases the one for ionization (S) compared to unirradiated plasmas. Numerical values of α and S are given for a hydrogen plasma irradiated by CO_2, ruby, and Ar-ion lasers. The calculations are based on a collisional-radiative model in which photoionization and stimulated recombination intervene. Stimulated recombination has an important effect and can lead to saturation of free-bound transitions at high power density of the laser beam as long as multiphoton ionization effects and plasma heating by inverse bremsstrahlung remain negligibly small. (GE)

12502 STRONG MAGNETIC FIELDS PRODUCED BY COMPOSITION DISCONTINUITIES IN LASER-PRODUCED PLASMAS. Tidman, D.A. (Science Applications Inc., Arlington, Virginia 22209). Phys. Rev. Lett. 32: No. 21, 1179-1181 (27 May 1974).

Magnetic fields in excess of 10^7 G are expected to arise in laser-produced plasmas in which a discontinuity in atomic weight of the target occurs in the focal spot. The upper limit to B is controlled by fluid disassembly of the field layer due to magnetic pressure. This may provide a means for direct measurement of these fields in laser-produced plasmas. (auth)

Stability

Refer also to abstract 12444.

12503 (IPPJ-166) SHEAR STABILIZATION OF THE COLLISIONLESS-DRIFT-WAVE INSTABILITY. Nishida, Y.; Dodo, T.; Kuroda, T.; Horikoshi, G. (Nagoya Univ. (Japan). Inst. of Plasma Physics). Jun 1973. 13p. INIS.

Stabilization of the drift wave instability by the magnetic shear is studied in a linear stellarator with $l = 3$ helical windings. The critical shear for stabilization strongly depends on the ion temperature, where ion temperature is controlled. Near stabilization, it is shown that the ion Landau damping becomes effective. (auth)

12504 DEVELOPMENT OF ACOUSTIC AND SUPERHEAT INSTABILITIES IN A PLASMA CONTAINING MOLECULAR IMPURITIES. Kruzhilin, N.A. (Institute of High Temperatures, Academy of Sciences of the USSR). High Temp. 11: No. 1, 12-16 (Sept 1973).

The dispersion and absorption of sound as well as local superheating of the gas is a nonisothermal plasma containing molecular impurities and carrying a current in a transverse magnetic field are analyzed for the case of small electron densities. (auth)

12505 EFFECT OF A UHF FIELD ON THE INHOMOGENEITY OF THE NONEQUILIBRIUM PLASMA OF A LOW-PRESSURE GAS DISCHARGE. Batenin, V.M.; Vokhmin, P.A.; Klimovskii, I.I. (Institute of High Temperatures, Academy of Sciences of the USSR). High Temp. 11: No. 1, 17-23 (Sept 1973).

An experimental apparatus for studying the effect of a UHF field on various forms of plasma instability is described. It is shown that the superposition of a UHF field on a dc discharge may under certain conditions reduce the plasma inhomogeneity without having any great effect on its average parameters. The suppression mechanism is indicated. (auth)

12506 STABILIZATION OF THE COLLISIONLESS TRAPPED-PARTICLE INSTABILITY BY SHAPING OF THE TOKAMAK CROSS SECTION. Glasser, A.H.; Frieman, E.A.; Yoshikawa, S. (Plasma Physics Laboratory, Princeton University,

Princeton, New Jersey 08540). Phys. Fluids 17: No. 1, 181-183 (Jan 1974).

Distortion of the cross sections of a tokamak has been suggested as a means of improving Ohmic heating and raising β. The effects of such distortion on the collisionless, electrostatic trapped-particle mode have been investigated and it is found that under certain conditions a maximum-J configuration can be approached. Results will be presented for finite elliptic and triangular distortions, indicating significant stabilization. (auth)

12507 CURRENT-DRIVEN MODES IN TWO-DIMENSIONAL PLASMA CONFIGURATIONS. Coppi, B.; Rem, J. (Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). Phys. Fluids 17: No. 1, 184-192 (Jan 1974).

A search for current driven modes in two-dimensional (toroidal) plasma configurations is made for regimes where the effective collision frequency of trapped electrons is smaller than their average bounce frequency and the drift velocity of the circulating electron is smaller than the thermal velocity. If the current carrying part of the circulating electron distribution function is represented by a Spitzer-Härm type of model, no significant growth rates of possible current driven modes can be found whether their wavelengths along the magnetic field are long or short in comparison with the field connection length. One reason for this is that in a realistic toroidal configuration, there are very few electrons with longitudinal velocities much smaller than the electron thermal velocity, which are not trapped and carry current. The only significant current driven instability found depends on the assumption that collisions or, possibly, the effects of higher-frequency fluctuations, may induce a sufficiently finite longitudinal thermal conductivity of the circulating electrons. (auth)

12508 INTERCHANGE DESTABILIZATION BY INCOMPLETE LINE-TYING. Prater, R. (Department of Physics, University of Wisconsin, Madison, Wisconsin 53706). Phys. Fluids 17: No. 1, 193-197 (Jan 1974).

A theory is presented for a plasma unstable to the interchange mode which shows that longitudinal current flow to conducting end plates can be destabilizing if the sheath impedance at the end plates is large or if the growth rate is small. This destabilizing effect is experimentally verified in a multipole-mirror device. For large growth rates, a stability criterion on the cold background plasma density is derived and compared with several experiments in the literature. (auth)

12509 SIDEBAND INSTABILITY IN THE WATER BAG APPROXIMATION. Bloomberg, H.W. (Department of Physics, College of William and Mary, Williamsburg, Virginia 23185). Phys. Fluids 17: No. 1, 263-265 (Jan 1974).

A self-consistent water bag distribution of trapped particles is used to numerically study the sideband instability of finite amplitude plasma waves. Equilibria including high and low concentrations of particles at the bottom of the wave troughs are considered. (auth)

12510 LINEAR THRESHOLD OF THE BUNEMAN-FARLEY INSTABILITY. Abhyankar, V.G.; Simon, A. (Department of Mechanical and Aerospace Sciences, University of Rochester, Rochester, New York 14627). Phys. Fluids 17: No. 1, 261-262 (Jan 1974).

The wavelength (k) dependence of the threshold drift velocity (v) for onset of the Buneman-Farley instability is determined. Inclusion of small terms omitted previously yields a finite k for minimum v, rather than $k = 0$ or $k = \infty$ as in two earlier studies. (auth)

12511 ELECTROMAGNETIC INSTABILITY IN HIGH β PLASMAS WITH GENERALIZED. Buti, B. (Space Science Division, Ames Research Center, National Aeronautics and Space Administration, Moffett Field, California 94035). Phys. Fluids 17: No. 1, 258-260 (Jan 1974).

Electromagnetic instability of waves propagating transverse to the external magnetic field of an anisotropic high-β plasma governed by generalized non-Maxwellian distribution functions is discussed. The region of instability is much smaller compared with that for Maxwellian plasma. (auth)

12512 STABILIZATION OF ION ACOUSTIC WAVES BY ELECTRON TRAPPING. Albright, N.W. (Department of Physics, University of California at Los Angeles, Los Angeles, California 90024). Phys. Fluids 17: No. 1, 206-210 (Jan 1974).

The unstable ion acoustic waves resulting from a beam of electrons entering a plasma are considered. A test wave is introduced in the region of unstable waves through the same boundary where the beam enters the plasma. This test wave has an amplitude much larger than the noice. The growth rate of this wave including the effects of electron trapping and collisions is calculated, and it is found that such a test wave will stabilize by electron trapping. (auth)

12513 SELF-CONSISTENT EQUILIBRIA AND CURRENT LIMITATION IN RELATIVISTIC ELECTRON BEAMS. Auer, P.L. (Department of Engineering Science, University of Oxford, Oxford, U.K. and Culham Laboratory, Abingdon, Berkshire, U.K.). Phys. Fluids 17: No. 1, 148-155 (Jan 1974).

Several classes of self-consistent equilibria are examined with a view toward establishing their general character. It is found that within the context of self-consistent equilibria current limitation in the sense of Alfvén and Lawson is not present per se. Practical considerations, however, would argue that this limit has rather broad validity in the strictly relativistic regime providing externally generated magnetic fields are absent. An example of potential practical interest in which field reversal occurs inside the beam while the bulk of it remains nearly force-free is discussed in some detail. (auth)

12514 ELECTROSTATIC CYCLOTRON HARMONIC WAVE INSTABILITIES IN BEAM-PLASMA SYSTEMS. Mizuno, K.; Tanaka, S. (Department of Physics, Faculty of Science, University of Kyoto, Kyoto, Japan). Phys. Fluids 17: No. 1, 156-162 (Jan 1974).

The cyclotron harmonic wave instabilities of a weak electron beam and a warm plasma system having a finite cross section in a finite magnetic field are investigated. Experimentally, it is shown, by using a test wave method, that the unstable cyclotron harmonic waves are observed in each cyclotron harmonic band and their dispersion curves have harmonic structure. Theoretical studies show that the observed instabilities are ascribed to the Cerenkov and cyclotron excitations (normal and anomalous Doppler effects), where the negative energy waves on the beam are coupled to the obliquely propagating cyclotron harmonic waves in the warm plasma in a magnetic field. (auth)

12515 FLUTE INSTABILITIES DURING FAST MAGNETIC COMPRESSION OF COLLISIONLESS $\beta = 1$ PLASMAS. Keilhacker, M.; Kornherr, M.; Niedermeyer, H.; Söldner, F.; Steuer, K. (Max-Planck-Institut für Plasmaphysik, Garching bei München, Germany). Phys. Rev. Lett. 32: No. 19, 1044-1047 (13 May 1974).

End-on framing photographs taken at the Garching 500-kV theta pinch during fast magnetic plasma compression [$n_0 = (1.5\text{-}4) \times 10^{13}$ cm^{-3}] show distinct radial filaments that are due to flute instabilities of high azimuthal-mode number. The observed wavelengths are of the order c/ω_{p_i}; they decrease with increasing density, but no mass dependence is found. The flute instabilities are responsible for the existence of a plasma halo which surrounds the thermonuclear $\beta = 1$ plasma column and has a major influence on its behavior. (auth)

12516 BRILLOUIN BACKSCATTERING AND PARAMETRIC DOUBLE RESONANCE IN LASER-PRODUCED PLASMA. Yamanaka, C.; Yamanaka, T.; Sasaki, T.; Mizui, J. (Institute of Laser Engineering, Osaka University, Suita, Osaka 565, Japan); Kang, H.B. Phys. Rev. Lett. 32: No. 19, 1038-1041 (13 May 1974).

Brillouin backscattering from laser-produced plasmas of hydrogen and deuterium has shown an isotope effect in the red-side region of the generated second-harmonic light. This isotope shift is explained by the parametric instability at the cutoff region using the phase-matching condition of the waves. The decrease of the reflectivity appeared when the laser intensity increased up to 1 order of magnitude larger than the threshold of the parametric instability. A broad-band laser showed more effective heating of the plasma than a narrow-band laser. (auth)

Thermonuclear Engineering and Equipment

Refer also to abstracts 12437, 12446, 12635, 12644, 12645, 12838, and 14105.

12517 (IPF-72-7) DEVELOPMENT AND INVESTIGATION OF A CONDENSER SUPPLIED MAGNETIC FIELD COIL TO PRODUCE A HOMOGENEOUS MAGNETIC FIELD IN THE 60 kG REGION. Hirsch, K. (Stuttgart Univ. (TH) (F. R. Germany). Inst. fuer Plasmaforschung). 1972. 28p. (In German). INIS.

To create a high, homogeneous, quasi-stationary magnetic field $B \geq 60$ kG, a modified Bitter core is used. The disturbance due to the mid-section with a diagnostic opening is balanced by two symmetrically segmented windings of the changing current density distribution. At the same time a large region of homogeneous field distribution is obtained in an axial direction. (GE)

12518 (UCID-15390) GENERATION AND RECOVERY OF TRITIUM IN THERMONUCLEAR REACTOR BLANKET USING HEAT PIPES. Werner, R. W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 3 Oct 1968. Contract W-7405-eng-48. 15p. Dep. NTIS $4.00.

Controlled thermonuclear reactors using the D-T reaction require a means of regenerating tritium so that cycle continuity is maintained. A unique way is suggested for satisfying the tritium needs. It is proposed that heat pipes using lithium as a working fluid be used as tritium producers in the blanket structure of a reactor. The tritium produced by the reactions ($n + Li^6 \rightarrow T + He^4 + 4.6$ MeV) and ($n + Li^7 \rightarrow n^1 + T - 2.47$ MeV) would then be trans-

ported within the heat-pipe body to an accessible processing point outside of the blanket. By diffusion or equivalent means, the tritium would be brought outside of the heat-pipe body and then processed for recycling. Heat pipes are explained as heat-transfer devices and as gas handlers and tritium producers. Operation at temperatures not less than 1400°K is required. (auth)

12519 A CONVENIENT METHOD OF INCREASING THE CIRCUIT DAMPING PRODUCED BY AN EXPLODING FOIL. Higgins, P.B. (Sandia Laboratories, Albuquerque, New Mexico 87115). Rev. Sci. Instrum. 45: No. 4, 602-603 (Apr 1974).

An exploding aluminum foil is used to increase the current damping in a series RLC circuit. This rapid damping technique is utilized in the discharging of kJ capacitor banks where strong kA surges in current interfere with low level instrumentation signals. (AIP)

12520 GENERATION OF INTENSE PULSED ION BEAMS. Humphries, S.; Lee, J.J.; Sudan, R.N. (Laboratory of Plasma Studies, Cornell University, Ithaca, New York 14850). Appl. Phys. Lett. 25: No. 1, 20-22 (1 July 1974).

An electrostatic vacuum triode is described in which it is possible to efficiently produce intense ion beams in the energy range around 100 keV for short times (~50 nsec). In experiments to date, results have shown excellent agreement with predicted behavior. Equivalent proton currents of almost 500 A have been obtained at a peak energy in excess of 100 keV. The triode can easily be adapted to existing electron beam facilities. (auth)

12521 FORMATION OF A PLASMA FOCUS IN AN EROSION PLASMA ACCELERATOR. I. Grishin, Y.M.; Kozlov, N.P.; Protasov, Y.S.; Khvesyuk, V.I. (N. E. Bauman Moscow Technical College). Sov. Phys.-Tech. Phys. 18: No. 7, 948-950 (Jan 1974).

An analysis is made of the first stage in the formation of a plasma focus in an erosion accelerator, i.e., of the processes occuring within the accelerator channel. The plasma contraction within the channel is found as a function of the flow rate and the parameters μ^2 and λ^2 on the basis of an approximation. The results agree with available experimental data. (auth)

12522 PRESENT STATUS AND PROBLEMS OF DEVELOPMENT OF NUCLEAR FUSION REACTOR. Yoshikawa, S. (Tokyo Univ.). Genshiryoku Kogyo; 19: No. 11, 9-24(Nov 1973). (In Japanese).

Present status and problems of the development of nuclear fusion reactors are explained together with the principle and the characteristic features of fusion reactors. Lawson's criterion was presented as a condition for the reactors. The apparatus, which will meet the Lawson's criterion, will be very large and expensive. A safety program, especially for T, will be necessary. Tokamak, a low-beta torus-type apparatus, has made successful progress in research. The achieved confinement time was $nt = 10^{12}$ sec/cc. The stellarator is another torus-type apparatus. An empirical scaling law obtained by the tokamak series of experiments shows the feasibility of the reactors. Heating of plasma, and the impurities due to the sputtering of the surrounding material are important problems. A high-beta torus and laser nuclear fusion are being studied. Present status of the studies in USA, USSR, France, and Germany is explained. A future program of development in Japan is proposed. (JA)

12523 FUSION REACTOR RESEARCH. Kenward, M. Eng. Dig. (Toronto); 20: No. 2, 29-30(Feb 1974).

Controlled thermonuclear fusion offers the eventual prospect of a limitless source of energy. An international team has begun work on the design of a European fusion research reactor at the United Kingdom's Atomic Energy Authority's (UKAEA) Culham Laboratory. If Euratom, the organization coordinating Europe's fusion research programs, goes ahead and builds the Tokamak machine being designed by the Culham team, Europe may have a fusion machine able to compete with anything in the world. (auth)

12524 TRANSMUTATIONS, RADIOACTIVITY, AND AFTERHEAT IN DEUTERIUM–TRITIUM TOKAMAK FUSION REACTOR. Vogelsang, W. F. (Univ. of Wisconsin, Madison). Kulcinski, G. L.; Lott, R. G.; Sung, T. Y. Nucl. Technol.; 22: No. 3, 379-391 (Jun 1974).

Calculations were performed to assess the effects of fast-neutron-induced transmutation reactions in the blanket region surrounding the plasma in a Tokamak fusion reactor. The production of both stable and radioactive isotopes is considered in three structural materials suggested for CTRs; Type 316 stainless steel, niobium–1% zirconium, and vanadium–20% titanium. The results show that significant changes in the composition of the alloys will be produced along with the generation of large amounts of helium and radioactivity. Of the three alloys studied from the point of view of chemical changes, radioactivity, and afterheat, the vanadium–20% titanium alloy appears to be most favored followed by Type 316 stainless steel and niobium–1% zirconium. (auth)

12525 INFLUENCE OF NONMETALLIC IMPURITY ELEMENTS ON THE COMPATIBILITY OF LIQUID LITHIUM WITH POTENTIAL CTR CONTAINMENT MATERIALS. Smith, D. L.; Natesan, K. (Argonne National Lab., IL). Nucl. Technol.; 22: No. 3, 392-404 (Jun 1974).

The thermodynamic aspects of nonmetallic element (i.e., oxygen, nitrogen, and carbon) interactions were analyzed for certain refractory metal–lithium systems of interest for controlled thermonuclear reactor applications. The results provide a basis for further experimental work necessary to establish the operating limitations of potential containment materials for lithium under controlled thermonuclear reactor conditions. The refractory metals niobium, vanadium, and molybdenum are considered as base metals for the containment of lithium; and titanium, zirconium, and chromium are of interest as potential alloying elements. Nonmetallic element interactions between refractory metals and lithium are analyzed in terms of the equilibrium distribution coefficients and the nonmetallic elements concentrations in lithium sufficient for compound (i.e., oxide, nitride, or carbide) formation to occur. The types of interactions, viz., embrittlement, compound formation, reduction in strength, or lithium penetration of the refractory metals, which will probably have the greatest effect on the corrosion rates and mechanical properties of niobium, vanadium, and molybdenum in a lithium environment are discussed. Additional compatibility effects produced by alloying these refractory metals with either zirconium, titanium, or chromium are discussed. The importance of a capability to monitor and control carbon and nitrogen at low concentrations in lithium is emphasized, as is the need to establish the levels at which these impurities can be maintained in a large lithium system. (auth)

12526 FUSION POWER: PAST, PRESENT AND FUTURE. Arch. Energiewirtsch.; 28: No. 6, 295-306(Mar 1974). (In German).

6 figs.; 2 refs.

A general survey is given of past, present and future developments in controlled thermonuclear research. (auth)

12527 NEW MOMENTUM FOR NUCLEAR FUSION. In the Max-Planck-Institut in Muenchen, a New Phase of Plasma Research Has Begun. Bruns, K. Welt (Hamburg); No. 26, 16(Jan 1974). (In German).

A flywheel of 3 m in height, made of 230 tons of best steel, will be installed in the Max-Planck-Institute for plasma physics. Scientists there intend to accelerate this flywheel up to 1,650 revolutions per minute for a period of ten seconds each (approx. 4,400 times the acceleration of gravity at the periphery of the wheel) in order to perform experiments under sun-like conditions (about 120,000 kW for the hydrogen plasma). (HK/CB)

12528 PROCEEDINGS OF THE FIFTH SYMPOSIUM ON ENGINEERING PROBLEMS OF FUSION RESEARCH. Conference held at Princeton, New Jersey, November 5–9, 1973. New York; Institute of Electrical and Electronics Engineers, Inc. (1974). 704p. (CONF-731114–). $25.00.

Separate abstracts were prepared for 97 of the included papers. Twenty-eight of the papers appeared previously in NSA. These may be found under CONF-731114 in the report number index. (MOW)

For abstracts of individual papers see: 12445–12449, 12471–12473, 12529–12613, 12635, 12644, 12645, and 12838.

12529 STRUCTURE RENEWAL AND MAINTENANCE REQUIREMENTS IN A FUSION REACTOR. George, M. W. (Atomic Energy Research Establishment, Harwell, Eng.). pp 21-25 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

The breeding blanket of a fusion reactor will be subjected to a fluence of neutrons of higher energy than has so far been obtained in reactor irradiations. It is unlikely that the effect of this radiation field, although to some extent predictable, will be fully demonstrated until a fusion reactor is built. This poses interesting problems for the reactor designer, some of which are discussed. An analysis is made of the nature of the problems arising. Examples are given based on familiar concepts, and assessments are made of their influence on the design and operation of fusion reactors. (MOW)

12530 HEAT TRANSPORT AND RADIATION DAMAGE OF A LINAS CTR BLANKET. Koehler, W. H.; Perry, R. T.; Voss, J.

(INTERATOM, Bensberg, Ger.). pp 26-30 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

A scoping engineering analysis of a Linas (Li-Na-Stainless Steel) blanket is presented. Results of the neutronics analysis are used to make predictions of the swelling in the stainless steel constructional material. Temperature profiles in the first wall, based on direct plasma radiation at the inner wall and volumetric heat sources, are presented. Thermal stress design limitations are indicated. (auth)

12531 EROSION OF STAINLESS STEEL FIRST WALL BY HELIUM BLISTERING. Das, S. K.; Kaminsky, M. (Argonne National Lab., IL). pp 31-36 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

The blister formation and the erosion rates associated with helium blistering in annealed 304 stainless steel were investigated for helium projectiles with energies ranging from 100 keV to 1.5 MeV and for irradiation temperatures ranging from room temperature to 550°C. The total dose was varied from 0.1 to 1.0 C/cm^2. The results show that the blister size increases with increasing projectile energy. The degree of blistering, and the erosion rates associated with blister rupture and exfoliation are found to be strongly temperature dependent. Maximum erosion rates were observed at irradiation temperature of around ~450°C. The erosion rates decreased at higher temperature ~550°C. The degree of blistering is found to increase with increasing dose. (auth)

12532 PARTICLE RELEASE FROM NIOBIUM UNDER 14-MeV NEUTRON IMPACT. Kaminsky, M.; Das, S. K. (Argonne National Lab., IL). pp 37-40 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

The particle release from cold-rolled and annealed polycrystalline niobium surfaces under 14-MeV neutron impact to a total dose of 4.6×10^{15} neutrons/cm^2 was investigated in two separate runs at ambient temperature and under ultrahigh and high vacuum conditions, respectively. The type and amount of material released and deposited on a substrate surface was determined independently by four analytic techniques. Surprisingly, there were two types of deposits—one in the form of large chunks, the other a more even layer covering the surface. For the cold-rolled niobium sample with a surface finish of 5 μm the estimated particle release value is $S = 0.25 \pm 0.10$ niobium atoms per incident 14-MeV neutron. A model for the chunk emission is suggested. (auth)

12533 HELIUM INDUCED SWELLING IN REACTOR CLADDING. Russell, K. C. (Massachusetts Inst. of Tech., Cambridge). pp 41-45 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

High intensity neutron fluxes expected in CTR power generation will produce huge supersaturations of vacant lattice sites, atoms in interstitial sites and helium atoms. These may combine to give numerous small helium-containing voids, which induce various degrees of swelling, depending on the material, temperature, and irradiation conditions. Such swelling is highly undesirable and should be minimized. A full transient theory of void nucleation is presented which accounts for the effects of gaseous and nongaseous impurities in the material (whether present originally or due to transmutation reactions) as well as effects of the vacant lattice sites and interstitial atoms. The complete theory is in the form of fairly complex difference equations; approximate, closed form solutions are presented for the special cases when the impurity atoms are very mobile in the lattice, or are essentially stationary. The former case is more important, as modest amounts of a mobile inert gas or mobile surface-active impurity may increase the void nucleation rate by many powers of ten—compared to coprecipitation of vacancies and interstitials only. Such impurities should thus be avoided as much as possible. Immobile impurities have a much smaller potential catalytic effect and may even preclude void nucleation by trapping mobile vacancies. We find that the incubation time for the establishment of steady-state nucleation is likely to be larger than the CTR pulse cycle. As such, void formation may well have to be approached as a transient phenomenon. Detailed predictions of void swelling must await better definition of CTR conditions and development of better ancillary data. (auth)

12534 EFFECT OF CYCLOTRON-IMPLANTED HELIUM ON THE FATIGUE BEHAVIOR AND MICROSTRUCTURE OF 316 STAINLESS STEEL AT 650°C. Michel, D. J.; Serpan, C. Z. Jr.; Smith, H. H.; Pieper, A. G. (Naval Research Lab., Washington, DC). pp 49-53 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

The effects of cyclotron-implanted helium and/or thermal aging on the fatigue behavior and microstructure of thin-section 316 stainless steel were investigated at 650°C. Annealed and 20% cold-worked fatigue specimens, implanted with 100 ppM helium, and TEM foil specimens, implanted with 10 ppM helium, were studied. All fatigue specimens were cycled to failure at 650°C in vacuum. The results show that the combined effects of helium-implantation and thermal aging significantly increase the fatigue life and reduce the crack growth rate of both annealed and 20% cold-worked 316 stainless steel at 650°C when compared with results for unimplanted and unaged specimens. Examination of the thermally aged, helium-implanted and unimplanted, foil specimens revealed massive carbide precipitate formation on grain boundaries and on dislocations within the solution-treated material. For the cold-worked foil specimens, carbide precipitates were observed primarily on dislocations and on stacking faults. No direct evidence of the presence of either helium or displacements produced by helium-implantation was found in the fatigue and microscopy foil specimens. It was concluded that the superior fatigue behavior of helium-implanted and thermally aged, thin section 316 stainless steel at 650°C resulted primarily from the microstructure produced by thermal aging. The effect of helium on the fatigue behavior of the annealed or 20% cold-worked stainless steel was only to supplement, in either a positive or negative manner, the effect of the microstructure. (auth)

12535 PROJECTION OF GRAPHITE BEHAVIOR: COMPARISON OF RESULTS ON FOUR CONCEPTUAL FUSION REACTOR DESIGNS. Gray, W. J.; Morgan, W. C. (Battelle-Pacific Northwest Labs., Richland, WA). pp 59-64 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

A very brief review of radiation effects in graphite is given followed by projections of graphite behavior in four fusion reactor design concepts: the ORNL Conceptual Fusion Reactor (Version III), the University of Wisconsin Tokamak (Austin Design), the LASL Reference Theta Pinch Reactor, and the PNL Fusion-Fission Hybrid Reactor. These projections are based on property changes observed for graphite samples irradiated in fission reactors and the calculated numbers of atomic displacements. Correlations between the relative numbers of atomic displacements in the fusion and fission reactor spectra were made using the Lindhard theoretical treatment of atomic stopping cross sections and neutron scattering cross section data from ENDF/B-III. The results predict graphite lifetimes of roughly 2500, 7500, 200, and 10,000 full power days for the above four reactor concepts, respectively, using the typical nuclear-grade graphites. Discussions of areas that require additional work to improve these and future projections are presented. (auth)

12536 2000 MW(e) FUSION REACTOR, AN OVERVIEW. Tenney, F. H. (Princeton Univ., NJ). pp 65-68 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

This is the first of a series of six papers discussing the Princeton Reference Design Model of a fusion power plant. A brief description is given of the toroidal, tokamak style, reactor with emphasis on the behavior of the poloidal field divertor. (auth)

12537 OPERATING CYCLE OF A LONG PULSE TOKAMAK FUSION REACTOR. Grainick, S. (Princeton Univ., NJ). pp 69-74 of Proceedings of the Fifth Symposium on Engineering Prob-

lems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

The operating cycle of the Princeton Reference Design Model Tokamak fusion reactor is described. A long pulse length design was chosen, i.e., $\tau_{pulse} \gg \tau_c$ where τ_{pulse} is the pulse length and τ_c is the containment time. Consequently, it is necessary to provide a divertor and fuel injection. The design envisions a flow through concept with a fractional burn of ~12%. The overall design parameters are summarized. (auth)

12538 BLANKET NEUTRONIC STUDIES FOR A FUSION POWER REACTOR. Price, W. G. Jr. (Princeton Univ., NJ). pp 75-78 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

Some of the important results of a full analysis of the neutronic aspects of the Princeton Reference Design Fusion Power Plant are reported. The design is judged (neutronically) practical, with a net tritium breeding ratio of 1.04 and an energy multiplication of 1.658. Radiation damage experiments will be required to predict the blanket lifetime at the predicted flux levels; radioactive waste disposal at the end-of-life will not be a simple problem. (auth)

12539 DESIGN OF THE HEAT TRANSFER SYSTEM FOR THE PRINCETON REFERENCE DESIGN REACTOR. Davison, P. W. (Westinghouse Electric Corp., Madison, PA). pp 79-86 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

The heat transfer system for the Princeton Reference Design Reactor is described with particular emphasis on the cooling of the breeding blanket. The power from the plasma is deposited in the divertor and the materials surrounding the plasma chamber. The 5305 MW of thermal power is removed by helium at a pressure of 50 atmospheres flowing through 2.54 O. D. tubes of NIMONIC Alloy PE-16. The helium leaves the reactor at 638°C and is transported to and from the twelve steam generators through manifolds, headers and ducts. The total helium flow rate is 3.3×10^6 g/sec. Of this, 90% is returned to the vacuum wall and breeding blanket cooling systems at 360°C. The remaining 10% is fed through two feedwater heaters and the helium clean-up system before being returned to the divertor and concrete shield cooling systems at 60°C. The pressure drop around the system, 2.6 atmospheres, is compensated for by 12 helium circulators — each driven by a 21 MW (28,000 hp) electric motor. The eutectic flibe in the breeding blanket must be circulated through a processing system to remove tritium and other materials. The blanket cooling system is designed to take advantage of this circulation to obtain improved heat transfer. The reactor is divided into 24 sectors and in each sector the blanket cooling system is divided into 23 sections to allow for accommodation of variations in the physical dimensions and in the power generation around the minor circumference. The design of a nominal blanket cooling section is described in detail. (auth)

12540 FUSION REACTOR FUEL HANDLING. Johnson, E. F. (Princeton Univ., NJ). pp 87-89 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

The features of the fuel handling system for the Princeton Reference Design Model, a tokamak machine generating 2 GW net electrical output, are described. The problems of fuel injection and plasma processing within the reactor and divertors are not treated here, but all other aspects of handling fuels are examined from the standpoint of practicable processing. In particular the areas of greatest uncertainty and greatest likely difficulty are identified to ensure an optimal focus in continuing and future studies. A general conclusion is that there are a number of interesting and difficult problems, but none is insuperably difficult, and relatively conventional technology will provide economically acceptable solutions. (auth)

12541 PROPOSED SUPERCONDUCTING COILS FOR THE PRINCETON FUSION REACTOR. File, J. (Princeton Univ., NJ). pp 90-96 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

A coil system is described along with the cooling and refrigeration requirements which provides steady fields up to 160,000 gauss and pulsed fields up to 30,000 gauss. Engineering drawings are given. (MOW)

12542 FUSION REACTOR DYNAMICS AND CONTROL. Sabri, Z. A. (Iowa State Univ., Ames); Husseiny, A. A. pp 97-98 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

Temperature coefficients of the design parameters are obtained using Mills' design criterion of self-heated steady state thermonuclear fusion reactor. Effects of variations of the tritium enrichment, the fraction retained in the plasma of the energy released to charged particles, and the ratio between the electron and the ion temperatures are investigated. Stabilization by means of affecting changes in the fuel injection rate is considered. Results are compared with those of Mills and Ohta, Yamato, and Mori. (auth)

12543 ENGINEERING DESIGN CONSIDERATIONS FOR LASER CONTROLLED THERMONUCLEAR REACTORS. Williams, J. M.; Finch, F. T.; Frank, T. G.; Gilbert, J. S. (Los Alamos Scientific Lab., NM). pp 102-106 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

Preliminary engineering analyses of LCTR power plants have revealed many challenging engineering problems, some of which transcend present technology. However, much of the technological development which has resulted from the fission reactor and space programs is applicable to the fusion reactor program as well. Although much analytical and experimental investigation remains to be done, no problems have been discovered for which there are not reasonable conceptual solutions. Intensive efforts to resolve these engineering design problems awaits successful achievement of thermonuclear burn from laser fusion. (auth)

12544 SOME DESIGN ASPECTS OF INERTIALLY CONFINED FUSION REACTORS. Bohn, F. H. (Kernforschungsanlage, Juelich, Ger.); Conrads, H.; Darvas, J.; Foerster, S. pp 107-111 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

A rough model (SATURN) of an inertially confined fusion reactor is outlined, with special emphasis on feasibility, reliability and safety aspects. Main reactor parameters are 5 GW thermal power, 20 m diameter of the vacuum vessel and a pulse rate of 100 Hz. The performance of modular design for the blanket, of vacuum and of fuel injection is discussed. Except for some observations, no consideration is given to the performance of lasers. (auth)

12545 WISCONSIN TOKAMAK REACTOR DESIGN: AN OVERVIEW. Emmert, G. A.; Conn, R. W.; Kulcinski, G. L. (Univ. of Wisconsin, Madison). pp 112-115 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

The basic parameters of UWMAK-I are summarized. The reactor is a tokamak system utilizing a double-null poloidal divertor. Some of the blanket and shield characteristics are also described. (MOW)

12546 BLANKET-COUPLED MHD FOR FUSION TO ELECTRIC ENERGY CONVERSION. Rosa, R. J. (Avco Everett Research Lab., Inc., Everett, MA). pp 125 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

A brief description of a MHD conversion system coupled to a fusion reactor by means of a graphite blanket is given. Temperature and efficiency measurements in the cycle are described. (MOW)

12547 DESIGN OF A FUSION REACTOR-TORCH SYSTEM. Sabri, Z. A. (Ames Lab., IA). pp 152-154 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

Skeletal structures of a fusion industrial complex comprised of a reactor for power production and a fusion torch for material processing are introduced. Engineering problems associated with design and economic operation of such a complex are identified and analyzed. Toroidal and open-ended devices are considered, and calculations of neutron fluence and charged particle flux are presented. Methods of reduction of neutron currents into the torch are described. Design limitations on the plasma environment in the torch are discussed. (auth)

12548 ASPECTS OF THETA PINCH POWER PLANT DEVELOPMENT. Coultas, T. A. (Argonne National Lab., IL); Krakowski, R. A. pp 155-162 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

An engineering conceptual design study of a fusion power plant based on the theta-pinch concept has recently been completed. This study presented a compatible design for ten major systems. Although the design appears viable, some systems need considerable development to show that they are completely feasible and credible. Interactions between systems prevent implementation of some obvious solutions to the individual problems. Design alternatives, development, and demonstrations, as well as fundamental research required on these systems to make a feasible theta-pinch power plant are discussed. (auth)

12549 BLANKET PROBLEMS RELATED TO DEMONSTRATION FUSION POWER REACTORS. Biggio, M.; Casini, G.; Cuniberti, R.; Farfaletti-Casali, F.; Peter, F.; Putzeys, J.; Volta, G. (EURATOM, Ispra, Italy). pp 175-188 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

First results related to the conceptual design of the blanket of an experimental fusion reactor which should precede the construction of a full-scale TOKAMAK prototype reactor are summarized. The analysis covers the modular blanket arrangement, the nuclear and thermal aspects of the design and some reliability evaluations. Liquid lithium, helium and stainless steel have been taken as blanket, coolant and structural materials, respectively. The first conclusions indicate that the proposed modular blanket arrangement seems attractive, insofar as it presents a good mechanical flexibility and a satisfactory nuclear and thermal behavior. The stress analysis of the structure has been started. (auth)

12550 EVALUATION OF MAJOR MATERIAL PROBLEMS ANTICIPATED FOR THE REFERENCE THETA-PINCH REACTOR (RTPR). Bunch, J. M.; Clinard, F. W.; Dudziak, D. J.; Green, W. V.; Krakowski, R. A. (Los Alamos Scientific Lab., NM). pp 189-202 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

The thermal and neutronic environment which is a consequence of the present RTPR design is briefly summarized. On the basis of this summary specific materials problems, anticipated solutions to these problems, and areas of uncertainty are enumerated and discussed. Whenever the present data base permits, quantitative assessment of problem areas are given. Areas of materials research which must be developed and/or extended are identified. (MOW)

12551 INDUCED RADIOACTIVITY IN THE LITHIUM COOLANT AND STRUCTURAL MATERIALS OF THE BLANKET SYSTEM. Persiani, P. J. (Argonne National Lab., IL). pp 203-205 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

The radioactivity induced in the coolant and/or blanket structural materials is studied for the LASL Reference Theta Pinch Reactor (RTPR). The initial computations indicate that the major contributions to the specific long-lived radioactivity in the lithium coolant result from the corrosion and sputtering processes of the radioactive Nb structure. (auth)

12552 PERMEATION OF HYDROGEN ISOTOPES THROUGH FUSION REACTOR MATERIALS. Levin, R. L.; Stickney, R. E. (Massachusetts Inst. of Tech., Cambridge, MA). pp 212-216 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

The design of a fusion reactor requires estimates of the rate of permeation of tritium through the various reactor components, e.g., the first wall, heat exchanger tubes, and the tritium recovery system. At present, these estimates must be based on the limited amount of available data obtained at pressures (or concentrations) that are substantially higher than those expected for fusion reactors. Therefore, the accuracy of these estimates depends upon the validity of extrapolating the available data to low pressures (concentrations). Analytical and experimental results are summarized which demonstrate that extrapolation leads to significant errors for certain materials at low pressures. (auth)

12553 ACTIVATION HAZARDS FROM FUSION NEUTRONS. Price, W. G. Jr. (Princeton Univ., NJ). pp 217-221 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

The neutron flux spectrum is computed and used to create energy-averaged activation cross sections. The magnitude of the flux is calculated from the fusion reaction rate. The activities of the radioisotopes produced are evaluated using the nuclide transmutation equation, and dose rates are obtained from these. (MOW)

12554 NEUTRONIC AND PHOTONIC ANALYSES OF FUSION REACTOR BLANKETS CONTAINING THORIUM. Parish, T. A.; Draper, E. L. Jr. (Univ. of Texas, Austin). pp 222-227 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

The thorium blankets considered here were found to possess the potential to produce an additional 9 to 12 MeV per fusion reaction while still producing about 0.311 ^{233}U nuclei per fusion neutron. The energy deposition in the niobium walls was reduced for these blankets. The heat deposition in the fissioning regions was not found to be excessively large although a detailed thermal hydraulic analysis was not performed. The energy leakage from these blankets was found to be less than from the standard blanket. (auth)

12555 THERMAL AND MECHANICAL DESIGN CONSIDERATIONS FOR LITHIUM-COOLED TOKAMAK REACTOR BLANKETS. Sze, D. K.; Stewart, W. E. (Univ. of Wisconsin, Madison). pp 228-234 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

A strategy is described for the design of lithium-cooled Tokamak reactor blankets. A design is proposed for a 5000 MW(th) D–T Tokamak reactor with a thermal wall loading of 1.77 MW/m^2 and a toroidal field on axis of 38.6 kG. Stainless steel is used for the structure and moderator-reflector material; lithium is used as

the coolant. A maximum coolant temperature of 500°C is imposed to limit the rate of corrosion of the stainless steel by the lithium. The coolant is supplied to the reactor at 283°C. The maximum coolant pressure at the first wall is 300 psia. The present design achieves a lower pressure drop despite a higher magnetic field, reduced blanket thickness and double wall loading. The improvement is due to changes in manifolding and in the moderator-reflector design. (auth)

12556 PARAMETRIC STUDY OF HELIUM COOLING AND ASSOCIATED ENGINEERING PROBLEMS OF FUTURE FUSION REACTORS. Hoffman, M. A.; Gasparotto, M.; Bertolini, E. (EURATOM-CNEN, Rome). pp 252-256 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

Helium cooling of future controlled thermonuclear fusion reactors is of great practical interest for several reasons including high heat transfer coefficients even at modest pressures, possible use of direct gas turbine cycle, no radioactivation of the helium, and no magnetic pressure drops (as encountered with liquid metals). In addition, previous studies have indicated that helium cooling of the reactor first wall and lithium blanket may be possible up to neutron wall loadings (i.e., neutron power fluxes across the first wall) as high as 10 MW/m^2. A parametric analysis is performed on a parallel-flow, tubular-wall blanket segment concept. Using a quasi-one-dimensional model of the segments, computations are performed to determine the permissible range of cooling tube lengths and diameters possible for various neutron wall loadings and radiation fluxes within acceptable stress limits, pumping power limits, and materials temperature limits. (auth)

12557 PARAMETRIC STUDY AND OPTIMIZATION OF CTR ENGINEERING DESIGN. Kasai, M.; An, S.; Kondo, S. (Tokyo Univ.). pp 257-266 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

The seriousness of the sputtering and the neutron radiation damage in the first wall of the fusion reactor blanket could be moderated by reducing wall loading or by employing reactor designs in which either the first wall can be exchanged easily or the vacuum wall is set outside of the neutron moderating zones The effectiveness of these strategies upon designs of closed type D–T plasma CTR were investigated by parametric survey using plasma power balance equation, the approximate relations for the nuclear reaction rates in the blanket based on the photo-neutronic transport calculations and the cost formulas for the first wall, blanket material and superconducting coil. (MOW)

12558 STRATEGY OF THERMONUCLEAR POWER EXPANSION: A MATHEMATICAL MODEL. Sabri, Z. A. (Iowa State Univ., Ames). pp 277-280 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

A mathematical model for future demand of electrical energy is used to find the optimum expansion plan for a metropolitan area. Increase in demand is assumed to be far less than the expected saturation value. The approach is characterized by the use of a general S-curve which properly describes the natural growth phenomena rather than the use of the energy coefficient to extrapolate the future demands. (auth)

12559 ENGINEERING AND MANAGEMENT ASPECTS OF THE ORMAK PROGRAM. Roberts, M. (Oak Ridge National Lab., TN). pp 281-285 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

This paper has two major objectives. The first of these is to lay the groundwork for succeeding ORMAK related papers in these proceedings. The second is to make clear the general work environment in terms both of the resources and the management requirements of the ORMAK program. (auth)

12560 250-kG MIRROR COIL DEVELOPMENT FOR THE LINEAR SCYLLAC EXPERIMENT. Hanks, K. W.; Boicourt, G. P.; Bailey, A. G. (Los Alamos Scientific Lab., NM). pp 314-317 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

The linear Scyllac theta-pinch machine required mirror coils on each end of the 5-m-long load coil which would give mirror ratios of two to three times the 100 kG main coil magnetic field. A pulsed magnetic field of 250 kG was established as a design goal for the mirror coils. Several different designs were evaluated using the 178-kJ, 60-kV Scyllac prototype capacitor bank. Calculations were made to determine the coil geometry for each 250-kG coil design. A copper lined, steel-jacketed coil, and an all steel coil were fabricated and tested. (4 to 5 cm bores.) The types of materials selected for each coil, strength considerations, and fabricating techniques will be discussed. The final design of the mirror coils for the 11.2 cm bore Scyllac machine was established using an all steel (Maraging type 250) design. An aluminum coil (2014-T652) was built and tested to failure in order to establish data as to the maximum fields that aluminum coils could be subjected to in a typical pulsed theta-pinch environment. This program and conclusions will be discussed. (auth)

12561 2XIIB PULSE COIL DESIGN. Bulmer, R. H.; Harvey, A. R. (Univ. of California, Livermore). pp 318-325 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

The design of the 2XII-B pulse coil system is presented. Development of the coil geometry is given as well as the results of magnetic field calculations. A discussion of the forces developed by this high energy coil set and the electrical stress on the magnet insulation is presented. The results of materials selection for both the coil insulation and structure is included and also a description of the fabrication procedure. (auth)

12562 PRINCETON'S PLT-MACHINE TOROIDAL FIELD COILS: DESIGN AND MANUFACTURE. Bushnell, C. W.; Heitzenroeder, P. J.; Linton, T. W. (Princeton Univ., NJ). pp 326-331 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

The toroidal field system requires 18 coils of 42 turns each. The coils have an O. D. of 99 inches, and I. D. of 63 inches, and each coil weighs 12,000 pounds. Design approaches are summarized with attention given to the details of cooling and insulation problems. Both size and production scheduling required that special handling techniques and manufacturing devices be utilized. Several of the special material handling devices are discussed along with the tooling for brazing, molding, machining, and finishing. (auth)

12563 PLT CONFINING FIELD COIL LOADING AND STRESSES. Frankenberg, J.; Citrolo, J.; Bonanos P. (Princeton Univ., NJ). pp 332-334 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

A stress analysis of the PLT Toroidal Field Coils is described and the results are summarized. The analysis assumes the coil to be a curved beam composed of homogenous isotropic material and includes the effect of (a) Lorentz forces varying inversely with major radius, (b) the elastic response of the coil support arrangement and external structure, (c) the azimuthally varying moment of inertia of the coil cross section, and (d) lateral loads applied normal to the plane of the coil arising from fields within the coil winding produced by other coils. (auth)

12564 PLT OHMIC HEATING ELECTRICAL SYSTEM. Murray, J. G.; Bronner, G.; Farley, R. D. (Princeton Univ., NJ). pp 335-338 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

A circuit to be used to heat the Princeton Large Torus plasma ohmically by inducing a current along the magnetic axis up to 1.6

megamperes and maintain it at approximately this magnitude for 0.5 seconds is described. (auth)

12565 PLT OHMIC HEATING RECTIFIER/DC STATIC BREAKER. Dewey, C. (General Electric Co., Philadelphia); Pollard, E.; Murray, J. G. pp 339-342 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

A new, unique design of a dc static solid state breaker, rated 22,000 amperes for several seconds and capable of interrupting the current with 20 KV maximum interrupting voltage is described. In addition, the breaker components are incorporated in a 12 pulse thyristor rectifier supplying the 22,000 amperes at 1100 volts. The rectifier is protected from damage by voltage limiting thyristor circuits and from overcurrents by firing suppression techniques. (auth)

12566 DESIGN ASPECTS OF OHMIC AND SHAPING FIELD COILS FOR THE PLT MACHINE. Johnson, H. G. (Princeton Univ., NJ). pp 343-349 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

The engineering design and fabrication of the windings that produce the ohmic heating and vertical shaping field for the PLT machine are described. The ohmic heating (OH) windings have 160 turns and are designed to operate at 22,000 amperes peak pulse current. The shaping field windings (SF) have 188 turns and are designed to operate at 7,200 amperes peak pulse current. The method of installing these windings inside the toroidal confining field coils is described. (auth)

12567 METHODS OF COMPUTING TOROIDAL DISCHARGE CROSS SECTIONS. Sheffield, G. V. (Princeton Univ., NJ). pp 350-352 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

The rise to prominence of Tokamak devices created a need for computational tools to evaluate and design these systems. Unlike stellarators, where magnetic design deals only with vacuum fields, a major part of the magnetic field of Tokamaks is created by the plasma discharger current. Thus, the position and shape of the plasma cross section is determined by the interaction of the plasma currents with the external fields. A computer code was developed to solve this problem. (auth)

12568 COMPUTATION OF PLT PLASMA CURRENT. Pelovitz, M. (Princeton Univ., NJ). pp 353-356 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

A plasma simulation program was developed which predicts the voltage response of a toroidal plasma to any arbitrary time dependent plasma current function. This program was used to examine the dynamic response and progress of the plasma breakdown as a function of time. (auth)

12569 DESCRIPTION OF THE SUPPORT STRUCTURE OF THE PLT. Citrolo, J.; Bonanos, P.; Frankenberg, J. (Princeton Univ., NJ). pp 357-359 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

The toroidal field coils of the Princeton Large Torus (PLT) are self-supporting with respect to the forces caused by the self field. However, an overturning moment, due to the interaction of the current in the coils and the non-coincident components of the plasma, ohmic heating and shaping fields, requires a structure to give lateral support to the coils. A structural center post is used to minimize the bending moment in the coil. In addition, the structure provides support to the vacuum chamber, ohmic heating and shaping field coils for the loading due to gravity and magnetic forces. This paper describes this structure and discusses its functions. (auth)

12570 OPERATION OF THE ORMAK FUSION DEVICE IN A CRYOGENIC, VACUUM ENVIRONMENT. Halchin, W.; DeCamp, S. M.; Lewis, S. O.; Lousteau, D. C.; Rylander, J. D. (Oak Ridge National Lab., TN). pp 360-363 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

The design specification of low aspect ratio, moderate magnetic field and long experimental time combine to indicate that ORMAK should be operated in vacuum with all elements cooled to liquid nitrogen temperature. Reliable operation for months at a time has resulted from attention given to a number of key points in the design. Recent modifications for installation of neutral beam injection heating equipment have been combined with improvements to each of the key areas developed over the two years of operating experience. Supplying liquid nitrogen coolant in parallel paths to 56 coils in four electrically seriesed circuits requires the use of many insulating connectors. These connectors and their field performed joints must be capable of withstanding 200 psi pressure of liquid nitrogen at 80 K with a voltage of 1 kV, while undergoing mechanical stresses and maintaining a helium tight vacuum seal. A carefully prescribed brazing installation procedure was evolved using an insulator that was developed jointly with Ceramaseal Inc. to perform this function. Other examples include the electrical insulating support structure holding many non-standardly shaped ohmic heating conductors to the torus shell, and cooling procedures for a large mass of various materials with different coefficients of thermal expansion. (auth)

12571 DEVELOPMENT OF THE 50 kG TOROIDAL FIELD COIL FOR HIGH FIELD ORMAK. Luton, J. N. Jr.; Brown, R. L.; DERBY, R. W.; Stoddart, W. C. T. (Oak Ridge National Lab., TN). pp 370-375 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

Azimuthally asymmetrical coils with winding depth ratios of about four offer appreciable power savings when tori with relatively small ratios of major to minor radii are required. The developmental work has been carried far enough to show that it is feasible to construct such asymmetrical coils both by (1) soldering partial-turn solid bars to a continuous hollow conductor with coil winding being carried out in the conventional way and by (2) machining the conductor spiral from a solid plate and inserting the hollow conductor into the groove thus formed. The additional copper of the asymmetrical coil also provides available thermal inertia for pulsed service and appreciable structural strength. (auth)

12572 CRYOGENIC ENGINEERING FOR ORMAK. Long, H. M.; Luton, J. N. Jr. (Oak Ridge National Lab., TN). pp 380-384 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

One of the largest toroidal experiments now underway in the U. S. controlled thermonuclear fusion program is the ORMAK device at the Oak Ridge National Laboratory. This device employs liquid nitrogen cooled copper coils to confine and heat a plasma in a toroidal field up to 25 kG using generators which supply 18 MW during a 1.5 second pulse every 10 minutes depositing up to 9.4 MJ of energy. This energy must be removed by the nitrogen cooling system and, in addition, the system must account for the external heat leak and two other magnetic coil systems as well as provide for cooldown and standby. The magnetic field coils are operated in parallel inside a vacuum tank, which provides thermal isolation for the coils, as part of a closed loop comprised of throttling valves, a holding tank, nitrogen to nitrogen heat exchanger and centrifugal pump. The pump circulates 450 liter/min against a back pressure of 2.85 atm. The system is pressurized to about 15 atmospheres to suppress boiling in the coils. The heat exchanger which operates as a vertical thermosyphon reboiler subcools the suction of the centrifugal pump to 80K from a maximum inlet temperature of 110K immediately after a pulse. The system is instrumented for automatic control of the nitrogen feed after manual start up and has been in service for over two years during which time over 4,000 experimental plasma runs have been performed. (auth)

12573 MECHANICAL INTERFACING OF THE HIGH POWER NEUTRAL INJECTION HEATERS TO ORMAK. Lousteau, D. C.; DeCamp, S. M.; Halchin, W.; Jernigan, T. C.; Lewis, S. O.; Morgan, O. B.; Rylander, J. D.; Stewart, L. D. (Oak Ridge National Lab.,

TN). pp 409–412 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

The Energetic Particle Injection Group of the Thermonuclear Division of the Oak Ridge National Laboratory has developed a source mechanism capable of producing a neutralized particle beam with power delivered to the plasma of up to 120 kW and pulse lengths up to 0.2 sec. The process by which these injectors are operationally coupled to ORMAK is described. (auth)

12574 200 AMP NEUTRAL BEAM SOURCE. Duffy, T. J. (Univ. of California, Livermore). pp 418–420 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

A test facility with sufficient pumping capacity to handle sources of this size has been built. The development of the ion source, mock-up extraction grid and the requisite electronic and power equipment for a 200 A neutral deuterium beam is discussed. The beam pulse length is from 2 to 10 msec. (MOW)

12575 SOLVING PROBLEMS OF NEUTRAL BEAM INJECTORS AT LLL. Chargin, A. K.; Anderson, C. J. (Univ. of California, Livermore). pp 421–428 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

Both mirror machines at LLL, Baseball II and 2XII, require neutral beam injection of hydrogen or deuterium into the plasma. The neutral beam injector components and their function in the injector system are discussed. Some of the problems with the ion sources, neutralizers, magnetic shielding, beam burial, and vacuum pumping are described. With the experience of successful operation of the neutral injectors in the plasma machines new neutral injectors are being designed. (auth)

12576 PARAMETER STUDY OF THETA-PINCH PLASMA PHYSICS REACTOR EXPERIMENT. Rogers, J. D.; Baker, B. L.; Weldon, D. M. (Los Alamos Scientific Lab., NM). pp 432–443 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

A parameter study of a superconducting magnetic energy transfer and storage (METS) driven theta-pinch plasma physics reactor experiment was made comparing direct and transformer coupled systems from the primary energy storage coil. Superconducting switches have been considered and both capacitive and noncapacitive transfer schemes were analyzed. Approximately twenty major cost items were included as a function of transfer time, plasma compression coil field, compression coil radius, primary storage coil field and current, peak voltage across the terminals of the storage coil, transformer turns ratio, spacing between the primary and secondary of the transformer coupled system, and ratio of resistances of a parallel resistor to the normal state superconducting switch. The study indicates the minimum cost system and provides direction for engineering design. A separated-shock, θ-pinch plasma experiment with shock heating by high-voltage circuits whose energy content is only a few percent of that of the total magnetic field energy has been examined. The compression field energy, which constitutes the bulk of the energy, is contained in a multiturn coil driven by a superconducting inductive energy source with millisecond transfer times appropriate to adiabatic compression of a θ-pinch plasma in long systems to obtain $kT \approx 10$ keV and $n\tau \approx 10^{14}$ cm^{-3} sec. The study optimizes the physical circuit values and costs of the entire system except the shock heating circuit, which is included, however, and is a nontrivial cost item. Switching of the stored compression energy is accomplished by a normal-going, superconducting switch. (auth)

12577 INVESTIGATION OF THE HOMOPOLAR MOTOR-GENERATOR AS A POWER SUPPLY FOR CONTROLLED FUSION EXPERIMENTS. Rylander, H. G.; Rowberg, R. E.; Tolk, K. M.; Weldon, W. F.; Woodson, H. H. (Univ. of Texas, Austin). pp 447–453 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

With the impending construction of large controlled fusion feasibility experiments, the need for reliable, inexpensive inertial energy storage to power the confinement magnetic field is becoming more urgent. To investigate the possibility of using a homopolar machine for this task, a series of electrical and mechanical tests on a 0.5 MJ unit operating as a pulsed power supply was carried out. The machine is motored up to a design speed of 6000 rpm using a 150 kw SCR power supply, and then, upon disconnecting the supply and connecting a load (short circuit), current pulses of up to 13 kA with a rise time of 25 ms are generated. The peak current and pulse decay time are limited by the armature circuit resistance, R_A. This in turn depends primarily on the amount of rotor surface covered by the brushes which, in the case of this machine, is only 1% leading to a relatively high R_A of 4×10^{-4} Ω. In addition, it was observed that up to 80% of the stored energy is delivered to the load. Motoring efficiencies are considerably less due to friction of the brushes and loading of the thrust bearing. An electromagnetic thrust bearing that is based on the principle of restoring the rotor to a position of magnetic equilibrium by differentially exciting field coils on each side of the central plane perpendicular to the axis of rotation is being tested. This process involves a photoelectronic device to sense the position of the rotor in order to control the field supplies. A 5 MJ single rotor machine capable of generating 100 kA at 5500 rpm and 45 volts is being constructed. This model will have substantially higher motoring efficiency and lower armature circuit resistance. Design features of this machine are discussed. (auth)

12578 ENGINEERING FEASIBILITY STUDIES OF INDUCTIVE ENERGY STORAGE FOR CONTROLLED FUSION DEVICES. McCann, R. B.; Rowberg, R. E.; Woodson, H. H. (Univ. of Texas, Austin). pp 454–458 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

The ability to supply pulsed energy on the order of 1 to 100 MJ on time scales of 0.1 to 10 ms is critical to many aspects of controlled fusion research. Use of magnetic energy storage for this purpose would provide an attractive means for doing this provided the problem of economical and reliable circuit interruption can be solved. Of the many possible methods for doing this, the use of conventional power circuit breakers (SF_6, vacuum, etc.) is favored because of their well developed technology and relatively low cost. The principal problems with these devices are the necessity of forcing a current zero to bring about interruption and to control the time-rate-of-change of current just prior to current zero and the time-rate-of-change of voltage just after interruption to values within the capability of the circuit breaker. By using commutating capacitors, voltage rate of rise limiting capacitors and saturable reactors this can be done. A circuit analysis was carried out on an inductive energy storage circuit employing these features with the goal of minimizing the system cost. By properly adjusting the required capacitance between the commutating circuit and that limiting the rate-of-rise of recovery voltage, a cost of $0.18 per joule (for capacitors and switches) was found for a system that delivered 10 MJ in less than 100 μs. This assumed use of a commercially available SF_6 breaker (Westinghouse 230SF20000) although the question of the optimum type of power circuit breaker is still open. Various factors influencing this choice are discussed. (auth)

12579 EXPLODING FOIL DEVELOPMENT FOR INDUCTIVE ENERGY CIRCUIT. Haarman, R. A.; Dike, R. S.; Hollen, M. J. (Los Alamos Scientific Lab., NM). pp 459–461 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

Copper foil fuses are used in the LASL Z-pinch CTR program to provide a method of transferring inductively stored energy, in an inductive storage system, from the storage inductor into the load with an $\dot{I} = 1.5 \times 10^{12}$ amps/sec. Contemporary fuses at LASL consisting of a copper foil folded around a small sheet of polyethylene and surrounded by an open box containing glass beads (sand) have experienced serious operating difficulties including debris being ejected between collector plates, deterioration of

contact electrodes upon firing, and difficulty of fuse replacement. A development program was initiated to design a fuse that could be used on the existing experiment and also on the proposed increased energy level ZT-S experiment at LASL. The ultimate goal was to obtain a single fuse package or pair of fuses (including an inverted fuse) capable of absorbing a total of 40 kJ energy. A fuse test header was built capable of testing fuse concepts to include inverted fuses, various arc inhibiting materials, and modes of energy absorbing methods. The energy system for the test header was a 60-kJ, 20-kV ignitron switched capacitor bank. The final fuse design is a 35 cm × 35 cm disposable package that consists of a hairpin shaped 1-mil-thick copper foil separated by a single 60-mil sheet of ABS plastic and sandwiched between two 1.2 cm layers of sand. The fuse package is capable of absorbing 20 kJ of energy without rupture, can be fired in an inverted position, and produces no contact burning or electrode degradation on the experiment. (auth)

12580 INVESTIGATIONS ON GENERATING HIGH CURRENT PULSES USING MAGNETICALLY STORED ENERGY. Braunsberger, U.; Salge, J.; Schwarz, U. (Technische Univ., Brunswick). pp 462–465 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

Results are given of investigations carried out on a system using magnetically stored energy to extend the duration of current pulses of capacitor banks. The current rise in the load is produced by the discharge of a capacitor bank and after this bank is crowbared the load is supplied from an inductive storage. Operational characteristics of circuit breakers opening the charging circuit, design of storage transformers, parallel operation of modules and reduction of the losses of circuit elements are also investigated. (auth)

12581 RELIABLE CAPACITORS FOR LARGE ENERGY STORAGE FACILITIES. Hutzler, J. R. (Aerovox Industries, Inc., New Bedford, MA); Dabrowski, G. M.; Young, M. P.; Lupton, W. H. pp 466–470 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

Operational reliability of complex capacitor banks is related to the failure rate of the capacitors used. A low failure rate is achieved by proper design for long life and extensive quality control to eliminate manufacturing defects. The design and manufacture of a typical caster oil energy storage capacitor is described. An adequately low failure rate during the useful life of the capacitor is assured by an acceptance test procedure. This acceptance test is illustrated by an order for 368 capacitors supplied to the Naval Research Laboratory by Aerovox. Additional data obtained from an extension of this test is also given. (auth)

12582 HIGH ENERGY DENSITY, LOW IMPEDANCE CAPACITORS USING PRESSURIZED WATER AS A DIELECTRIC. Miller, A. R. (Maxwell Labs., Inc., San Diego, CA). pp 471–474 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

The breakdown strength of a water dielectric capacitor system was significantly increased by moderate pressurization. Breakdown stress of 608 kV/cm was observed in a 12 nF, 0.5Ω water capacitor operated at a pressure of 67 atmospheres when the resonant charging time was 0.5 μsec. The interelectrode spacing was 1 cm. Substantially increased breakdown stresses were also noted at longer charging times. The highest stresses observed correspond to stored energy densities over 1 megajoule per cubic meter. In addition, preliminary results of the operation of a low impedance coaxial pressurized water capacitor will be discussed. The experiments generally support Abramyan's claim that significant improvement in the energy storage capability of water can be achieved in practical systems by pressurization. (auth)

12583 MOVING ENERGY STORAGE CAPACITOR RACKS WITH AIR BEARINGS. Banta, J. J.; Hammer, C. F. (Los Alamos Scientific Lab., NM). pp 475–478 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

Although Scyllac was proposed in 1966 as a 15-m-circumference toroidal apparatus, it was initially installed as a dual device; a 120° 5-m-long toroidal-sector experiment and a 10-m-long linear experiment with mirrors on each end. After preliminary experiments were completed, conversion of the equipment to a full-torus configuration was started early in 1973. One of the major conversion tasks was the moving of 30-ft-long × 7-ft-wide × 37-ft-high, 65-ton racks loaded with energy storage capacitors into a toroidal configuration. The original conversion scheme involved the disassembly and unwiring of each rack and reassembling it in its new position. This would have been expensive and time-consuming. This plan was abandoned when a careful study showed that an entire rack structure could be moved as one assembly on air bearings. The air bearings used were round, flat devices that were commercially developed to move considerable loads while supporting them on a cushion of constantly escaping low-pressure air. After the machine and capacitor racks were firmly clamped together with large structural beams, 42 air bearings were installed underneath. The air bearings were supplied with air at about 18 psi to raise the entire structure about $\frac{1}{8}$ in. The racks were moved to their new locations with "come-along" jacks and muscle power. The use of air bearings saved nearly one-half million dollars in electrician and rigger time. (auth)

12584 2°K VACUUM PUMPING SYSTEM FOR BASEBALL II. Denhoy, B. S. (Univ. of California, Livermore). pp 479–484 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

A vacuum pumping system is described that provides a cryosurface for condensing and freezing of H_2 gas. A closed loop vacuum system was designed and built to pump down the neutralizer LHe dewar with a volume of 350 l and the lambda point dewar with a LHe volume of 250 l. The mechanical design and performance are discussed. (MOW)

12585 MECHANICAL DESIGN OF 70 kV PULSED FLOATING DECK SWITCH. Foote, V. S.; Christie, R. S. (Princeton Univ., NJ). pp 489–492 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

Part of the electronic equipment used in the neutral injection apparatus on Princeton Plasma Physics Laboratory's ATC machine is a hard-tube, high-voltage, pulsed floating deck switch. The switch is designed around an Eimac Y-546/4CX35000C air-cooled tetrode tube. The mechanical design of the switch and its cooling system are described. Some of the problems encountered in design and during manufacture are related. (auth)

12586 LIMITERS. Christie, R. S. (Princeton Univ., NJ). pp 493–495 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

In the fusion research devices currently being operated at Princeton University's Plasma Physics Laboratory, limiters are used for a number of purposes. Some are used to direct and/or size the plasma, and some are used as a diagnostic tool to measure plasma parameters. Others are used for combinations of purposes. The mechanical design and details of some of the limiters being used in the various PPL machines are described. (auth)

12587 PPPL DATA ACQUISITION SYSTEM. Thompson, P. A.; Bennett, F. K.; Greenberger, A. J.; Mirro, E. Jr.; Schweitzer, S.; Slusky, S. G. (Princeton Univ., NJ). pp 498–502 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

The current status of DAS-1800, the data acquisition system built around an IBM-1800 computer, is reported; hardware and software developments allowing the concurrent servicing of ST, FM-1, and ATC are described; and details are given of the changes in usage of DAS-1800 during the same three and a half years of its existence. Finally, plans are discussed for providing similar data acquisition services for PLT when it starts operation in about two years. (auth)

12588 SOFTWARE SUPPORT FOR DAS-1800. Slusky, S. G.; Thompson, P. A. (Princeton Univ., NJ). pp 503-507 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

Software written both by the user-physicists and by members of the DAS-1800 software support staff provides analysis, display, and archiving facilities for experiments run on the three major devices at PPPL. DAS-1800 uses an IBM-supplied monitor with locally-written additions and modifications. A summary is presented of the DAS-1800 applications to the various experiments it serves. (auth)

12589 PRACTICAL APPLICATION OF A DIGITAL CONTROL SYSTEM. Simon, E. D.; Duritt, S. P.; Robertson, R. R. (Princeton Univ., NJ) pp 508-510 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

Operation of the FM-1 research device at the Princeton University Plasma Physics Laboratory utilizes an IBM-1800 Process Controller for numerous control functions. The device has been operational since 1971 and controls for another device, ATC, were added and operational in 1972. The time scale and cost aspects, as well as reliability and user reactions, are discussed. (auth)

12590 EMPLOYMENT OF PARTLY FORCE-FREE TOROIDAL MAGNETIC SYSTEMS FOR PRODUCING STELLARATOR-TYPE TRAPS. Georgievskii, A. V.; Ziser, V. E.; Litvinenko, Y. A. (Physical-Technical Inst., Kharkov). pp 511-514 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

General expressions are derived for integral electrodynamic forces in helical toroidal magnetic systems. On the basis of obtained results we have considered the problem of torsatron magnetic system optimization from the viewpoint of force compensation. The results of experimental checking were given on the torsatron-type models and working machines for various types of electrodynamic force compensation. (auth)

12591 POWER BALANCE STUDIES FOR A POSSIBLE TECHNICAL FEASIBILITY TOKAMAK FUSION REACTOR. Bertolini, E.; Hoffman, M. A.; Engelmann, F. (EURATOM-CNEN, Rome). pp 515-521 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

The dimensions of a toroidal D–T fusion reactor to demonstrate technical feasibility are discussed, taking into account limitations imposed both by plasma physics and by technology. For the plasma behavior, the collisional transport effects are used as a point of reference. (auth)

12592 TOROIDAL PINCH APPARATUS ETL TPE-1. Takeda, S.; Ikeda, N.; Kiyama, S.; Maejima, Y.; Shimada, T.; Hirano, Y.; Sato, Y.; Sugiura, M.; Yahagi, E.; Ogawa, K.; Tamaru, T. (Ministry of International Trade and Industry, Tokyo). pp 522-526 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

The toroidal Pinch Apparatus, ETL TPE-1, completed recently is described. TPE-1 is designed to study the confinement of a toroidal pinch plasma by a combination of axial (B_z) and azimuthal (B_θ) magnetic fields with an initial bias (B_z) field. The discharge tube is a pyrex glass torus of 80 cm in the major diameter and 10 cm in the minor diameter. It is surrounded by an aluminum alloy shell which has four flanges for feeding the fast I_z current (21 kJ, 40 kV). The thirty-six one turn I_θ coils surround the I_z shell and are connected to the main fast θ bank (160 kJ, 40 kV), preheat bank (0.8 MHz, 1.3 kJ, 40 kV) and bias B_z bank (2 kHz, 115 kJ, 5 kV) through six collector plates. The electrical insulation of coils has been successfully done by means of fluidized bed coating of epoxy powder. The toroidal plasma current is 100 kA, the I_θ current 4 MA, the maximum B_z field 20 kG and bias B_z field is ±4 kG. The capacitor banks, the electrical and mechanical design of the load assembly, the construction of whole assembly and the testing results are described. (auth)

12593 NRL IMPLODING LINER EXPERIMENT: SUZY II. Young, M. P.; Ford, R. D. (Naval Research Lab., Washington, DC). pp 527-531 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

SUZY II is a pulsed experiment designed to study the imploding characteristics of metallic liners. The experiment is part of the LINUS Program at the Naval Research Laboratory. Studies are being made with a 560-kJ capacitive energy storage source, and later studies will be made using multimegajoule inductive energy storage sources. Various metallic liners up to 11½ in. in diam and 2 in. long will be imploded with times in the order of 50 μs. The energy storage module assembly consists of a collection of 16 capacitor units (1.85 μF, 60-kV) eight above and eight below a median plane. The assembly forms a 3-conductor parallel-plate transmission line. Ten of these 56-kJ modules make up the total bank and, by means of exploding-foil-type starting switches, are connected into a parallel-plate transmission line collector plate positioned at the same median plane. Chemical-detonator-type clamp switches are located at the juncture of the collector plate and ballast inductance of the load coil. This layout is appropriate for a low-inductance, low-cost, 60-kV capacitor bank operated in an air environment. The electrical circuit has a combination of lumped paralleled capacitor and transmission line characteristics; however, for driving a 360-nH load its effective inductance is less than 10 nH and will produce a current waveform with a 13-μs risetime and a 50-μs L/R decay time. The control and monitoring system allows for a shot-to-shot time of less than 30 min., with great emphasis on remote control and safety. Facility operation with the appropriate diagnostics for liner studies is expected in late 1973. (auth)

12594 ENGINEERING OF THE 1.6 MJ PLASMA EXPERIMENT TENQ. Dokopoulos, P. (Kernforschungsanlage, Juelich, Ger.); Goering, D.; Kohlhaas, W.; Liedtke, A.; Stickelmann, C. pp 537-544 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

TENQ is a device for the study of the confinement of an axisymmetric toroidal plasma (major radius R = 45 cm, current $I \approx 300$ kA) with a noncircular cross-section of an ellipticity $\epsilon \approx 1$ to 4 and a safety factor of $q > 1$. The plasma should be heated by fast magnetic compression or Joule heating. The toroidal plasma vessel, made of ceramic and glass, has a mean radius of 45 cm and a rectangular cross-section of 46 cm width and 108 cm in height. It is surrounded by five coil systems, provided for preheating, bias-field, plasma-heating and toroidal field (7 kG), vertical field and for changing the plasma cross-section. They will be energized by 5 capacitor banks with a total energy of 1.6 MJ and current rising times adjustable from 9 to 63 μs, while the maximum voltage applied across some of the coils will be up to 96 kV. The design and the development of the system are described. The development of some essential components is also reported: A novel pulse transformer 20/96 kV with variable transformation ratio, the crowbar system, collector clamping elements, low inductance bushings and an electronic device protecting the system against unintentional breakdowns. (auth)

12595 ENGINEERING TESTS AND PRELIMINARY OPERATION OF THE ATC. Citrolo, J.; Frankenberg, J. (Princeton Univ., NJ). pp 548-549 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

A principal feature of the ATC design is the incorporation of toroidal field coils which are self-supporting with respect to the centering force and the magnetic pressure of the toroidal field. In this sense, these coils receive no support either from the structure or coil cases. The copper in the coil is the major structural element. Since the stresses in the coil are very high, engineering tests were incorporated in the machine erection schedule to insure the adequacy of the design. This paper describes the preliminary

tests which were made after the installation of the toroidal field coils and the final tests after completion of the machine. (auth)

12596 ENERGY SYSTEM FOR PLASMA HEATING IN THE ADIABATIC TOROIDAL COMPRESSOR. Turitzin, N. M. (Princeton Univ., NJ). pp 550-554 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

Plasma within the Adiabatic Toroidal Compressor (ATC) machine is heated by means of two independent systems: ohmic heating (OH) and compression heating (SF). The ohmic heating system comprises three parallel-connected energy sources: a dc generator, a 10 kV conventional capacitor bank, and a large 750 volt electrolytic capacitor bank. The compression circuit consists of two parallel-connected energy sources: a large electronic tube power amplifier and a 20 kV capacitor bank. A square voltage pulse from a generator establishes a dc current through the OH coil on the machine. It is followed by an opposite polarity discharge from the hv OH capacitor bank which drives the coil current down and induces a current in the plasma. The downward change in current is extended further by the discharge of the lv OH bank. While the ohmic heating is in progress, the electronic power amplifier maintains the plasma ring in position within the vessel. At the end of a preset time the compression bank is switched in. This drives the plasma from the wider end of the machine to its narrower end, thus compressing it adiabatically and raising the temperature and the density of the plasma. Different energy sources, their interconnection, protection, and interaction are discussed. The heating cycle is described and the behavior of plasma is shown. (auth)

12597 THREE-DIMENSIONAL MECHANICAL STRESSES IN TOROIDAL MAGNETS FOR CONTROLLED THERMONUCLEAR REACTORS. DeMichelet, D. W.; Darby, J. B. Jr. (Argonne National Lab., IL). pp 558-569 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

It appears that when considering the field limits of toroidal superconducting magnets, the mechanical stresses on the coils will be a primary limitation. The results of a detailed analysis of the forces and resultant stresses imposed on the magnet coils are presented. Two coil geometries have been analyzed; the circular coil toroid similar to the Oak Ridge design, and the "D"-shaped coil similar to the design proposed by the Princeton Plasma Physics Laboratory. Stresses calculated by a three-dimensional analysis are presented for the coils under normal and abnormal operating conditions. The abnormal condition considered is the unexpected "quench" of an adjacent coil resulting in asymmetric magnetic fields. The three-dimensional magnetic fields, within the current-carrying conductors, were calculated to determine the body forces. A three-dimensional, finite-element elastic stress analysis code, "Solid Sap", was used to evaluate the resultant mechanical stresses. (auth)

12598 FIELD SHAPING COIL DESIGN IN DOUBLET IIA. Schupp, A. A. Jr.; Baker, C. C.; Tamano, T. (Gulf General Atomic Co., San Diego, CA). pp 570-573 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

Doublet IIA is a device for testing different plasma configurations which employs the same basic structure, main toroidal coil, vacuum system, and power supplies as Doublet II. The thick copper field shaper of Doublet II will be removed and replaced with 24 field-shaping coils around a 36 cm by 105 cm rectangular shaped, thin-walled stainless steel torus which serves as the primary vacuum wall. Removing the copper field shaper will also necessitate modification of the toroidal electric field coil. In order to provide sufficient flexibility for various plasma shapes and to provide for plasma currents of up to 300 kA, provisions are made so that each field-shaping coil can be individually driven up to 100 kA-turns. Techniques for providing thermal insulation of the coils during discharge cleaning and methods for protection against plasma voltage spikes are presented. The programming of the current in the field-shaping coils is discussed and examples are given for various plasma shapes. In addition, diagnostic access of Doublet IIA is increased over Doublet II, and the type and location of the diagnostic ports are discussed. (auth)

12599 ELASTIC STABILITY OF A SUPERCONDUCTING COIL FOR A FUSION REACTOR. Moon, F. C. (Princeton Univ., NJ); Chattopadhyay, S. pp 574-578 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

An analysis of the elastic stability of a superconducting coil for a proposed fusion tokamak reactor torus is presented. It is shown that magnetically induced tension in the coil will stiffen or increase the out-of-plane, vibratory frequencies, while the variation of stress in the coil thickness will destabilize or decrease the natural frequency. In addition it is shown that destabilizing, deformation-dependent, magnetic forces will act on the coil for out-of-plane bending, similar to those that occur in a kink instability. It is found that these forces acting alone could buckle the coil at a current below the design value. A variational method, employing the change in inductance of the coil with deformation, is used to calculate the critical current. It is proposed to test the stability of such structures by measuring the natural frequencies as the current is increased. A decrease in frequency with current might indicate a possible instability at higher values of the current. (auth)

12600 PROGRESS ON ALUMINUM-CLAD Nb_3Sn. Henning, C. D.; Nelson, R. L.; Ward, C. O.; Rowe, C. L.; Moon, D. W. (Univ. of California, Livermore). pp 579-581 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

Adequate means for aluminum bonding have been found, and better methods are under investigation. All aspects of aluminum resistivity are characterized except for magneto-galvanic effects; these will require further work. Cryogenic stability of Nb_3Sn superconductors has achieved the desired current density of 10,000 A/cm^2 at low fields with some circulation of helium to prevent vapor-locking in the magnet windings. To eliminate the need for circulation, aluminum resistivity ratios above 5,000 will be necessary, while proper account must be taken of the aluminum magnetoresistance due to temperature and field orientation. (MOW)

12601 PERFORMANCE OF MEDIUM-SIZED Nb_3Sn COILS IN He GAS UP TO 17 K. Jaeckel, H. J.; Kisslinger, J.; Rau, F. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). pp 582-586 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From 5th symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

Two medium-sized superconducting coils with stored magnetic energy up to 50 kJ each, made from Nb_3Sn tape, are studied in He gas up to a temperature of 17°K, by measuring coil currents and local magnetic field components until the quench occurs. At elevated temperatures above 11°K the quench radial magnetic field approaches the radial penetration field as estimated in a simple model. Local magnetic field measurements appear to show diamagnetic effects in the tape. The correlation of the experiments to problems of the construction of large superconducting coils for toroidal fusion research magnets is discussed, especially with respect to the optimization of coil geometry and the minimization of the number of magnet modules necessary for a torus sector experiment. (auth)

12602 NASA SUPERCONDUCTING MAGNETIC MIRROR FACILITY. Reinmann, J. J.; Swanson, M. C.; Nichols, C. R.; Obloy, S. J.; Nagy, L. A.; Brady, F. J. (Lewis Research Center, Cleveland). pp 587-591 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From fifth symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

The design details and initial test results of a superconducting magnetic mirror facility that has been constructed at NASA Lewis Research Center for use in thermonuclear research are described. The magnet system consists of four solenoidal coils which are individually rated at 5.0 T. Each coil is composed of an inner, middle, and outer winding. The inner winding is wound of stabilized Nb_3Sn superconducting ribbon, and the middle and outer windings are wound of stabilized Nb–Ti superconducting wire. When arranged in the mirror geometry, the four coils will pro-

duce 8.7 T at the mirrors and a 1.8 mirror ratio. The magnet has a 41-cm diameter clear bore which is open to atmosphere. Distance between the mirrors is 111 cm. Presently there are only three magnets in the facility; the fourth magnet is being rebuilt. (auth)

12603 DESIGN OF A 100 KILOGAUSS HYBRID SUPERCONDUCTING MAGNET TEST FACILITY. File, J.; Willard, J. W. (Princeton Univ., NJ). pp 592-596 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From fifth symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

Design of a facility for simulation of the 1/R field of a typical 16 coil toroidal field system is described. The facility contains seven superconducting coils arranged in a wedge formation and housed in a common liquid helium dewar. The constant tension "D" coil of the facility will have a 96 cm bore. This will be the largest 100 kilogauss coil of this type built to date. (auth)

12604 TOROIDAL MAGNETIC SYSTEMS WITH SPATIAL MAGNETIC AND FLAT GEOMETRIC AXES. Georgievskii, A. V.; Ziser, V. E.; Nemov, V. V.; Skoblik, M. N.; Shishkin, A. A. (Physical-Technical Inst., Kharkov). pp 605-612 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From fifth symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

The magnetic field of the solenoid, the plane of which is oriented normal to the helical line, was studied. Analytical expressions are derived to define characteristics of a magnetic configuration produced by combination of the given solenoid fields and stellarator helical conductors. Some examples of the magnetic surfaces are discussed in linear approximation. The toroidal case was studied by means of computers. (MOW)

12605 DESIGNS FOR REFLECTIVE OPTICS IN FUSION SYSTEMS. Enzmann, J. M. (Northeast Cryonics, Inc., Lexington, MA). pp 633-639 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From fifth symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

Using reflective optics, several new systems of laser-induced fusion and improved plasma-pinch devices are proposed. These systems use arrays of reflective lenses which can: (1) expand, (2) add, (3) compress, (4) amplify, and (5) recirculate beams or pulses. A reflection system is described that will expand a beam's diameter until the intense flux is decreased to where it may be manipulated with reflective surfaces without significantly damaging them; coherently add pulses of CW outputs of several lasers by shared aperture techniques; compress into a single-spot, swept-line, or movable-spot with a diffraction limited accuracy above a reactive volume; amplify pulses by reusing them over their durations, thus effectively compressing them; and finally it can recirculate the pulse to recover some of its energy for pumping up the next cycle. (MOW)

12606 COMPACT ELECTRON BEAM GENERATORS FOR LASER AND FUSION RESEARCH. Harrison, J.; Kolb, A.; Miller, R.; Shannon, J.; Smith, J. B. (Maxwell Labs., Inc., San Diego, CA). pp 640-652 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From fifth symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

High power pulse electron beam generators have increasing applications to the fusion program, both in plasma heating experiments and as a pump for direct excitation of high power uv lasers. A class of compact water insulated machines has been developed for application to fusion oriented research. Generators can be built with output voltages up to 2 MV, energy delivered up to 20 kJ and peak powers of up to 4×10^{11} watts. Characteristic impedances are from 2 to 10 ohms. The output pulse with a command firing signal can have a jitter as low as 5 ns. Recent improvements in analysis techniques allow close agreement between calculated and observed output characteristics. This has been demonstrated on machines with a wide variety of characteristic impedances. (auth)

12607 DEVELOPMENT OF THE HIGH-EXPLOSIVE DRIVEN CROWBAR SWITCH. Dike, R. S.; Kewish, R. W. Jr. (Los Alamos Scientific Lab., NM). pp 658-663 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From fifth symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

A compact explosively-driven, metal-to-metal contact, solid dielectric switch was developed for use as a low-resistance, < 10-μΩ, low-inductance, < 10-nH, crowbar switch. A 100 milligram high-explosive charge is used to extrude a 0.090-in. plate through 0.040-in. polyethylene and achieve a hard current contact with a 0.625-in.-diameter die plate. The closure time, from the signal, which initiates the charge, to beginning of current rise in the switch, is 11.0 μsec ± 0.3 μsec. In crowbar application the switch has carried 180 to 330 kA which decays with a 1/e time of ≈ 1.2 msec. (auth)

12608 DESIGN OF A HIGH-VOLTAGE GENERATOR FOR THE LASL IMPLOSION-HEATING EXPERIMENT. Hammel, J. E.; Henins, I.; Marshall, J.; Sherwood, A. R. (Los Alamos Scientific Lab., NM). pp 664-666 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From fifth symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

The design of a high-voltage pulse generator is described. Systems which were considered are: (1) Mylar-insulated stripline Blumlein generators, (2) simple Mylar striplines, (3) combinations of Mylar striplines with capacitors, (4) water-insulated coaxial transmission lines, (5) capacitors, and (6) lumped-constant transmission lines. The system finally selected is a hybrid of a peaking-capacitor system with a curtailed, lumped-constant delay line. All systems were investigated by computation, mostly using the NET-2 code. The calculation takes into account the changing impedance of the load due to the motion of the imploding plasma sheath. Plasma dynamics were simulated using the bounce model, which assumes perfect elastic reflection of all ions from impinging magnetic piston. The final design employs four coil feed points with a 125-kV generator at each one, totaling 500 kV. Each 125-kV generator consists of a pulse-charged two element lumped-constant line. An essential feature of the circuit is fast charging from Marx generators through the inductance of the Marx and of the connecting cable system. The load switches are fired when the voltage on the lumped-constant line reaches 125 kV, at this time the voltage is still rising rapidly. At the peak load current about 300 kA is contributed by the charging current from the Marx bank and 500 kA comes from the capacitors of the lumped constant line. (auth)

12609 HIGH-VOLTAGE TECHNOLOGY FOR THE LASL IMPLOSION-HEATING EXPERIMENT. Hammel, J. E.; Henins, I.; Marshall, J.; Sherwood, A. R. (Los Alamos Scientific Lab., NM). pp 667-669 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From fifth symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

The implosion-heating power supply uses four 125-kV generators in series. Each generator consists of a fast 125-kV pulse-forming network made up of capacitors attached to a 1-m-wide parallel plate transmission line which is fed through multiple cables from a 2.5-μF, 0.5-μH Marx bank charged to 180 kV. To simplify construction it was decided to do without oil or water for high-voltage insulation and grading. The developments described here are: (1) a low-inductance connection between the 125-kV capacitors and the parallel plate transmission line using an elastomer gasket capable of holding 200 kV; (2) edge flashover prevention by "ballooning" the sheet insulation, by which a 10-cm edge extension of insulation is capable of withstanding a 200-kV pulse for several microseconds; (3) using the edge flashover for overvoltage prevention; (4) grading of voltage along insulators with conducting plastic sheets to prevent flashover at the load switches and cable connections; and (5) capacitively graded insulating supports for the Marx banks. (auth)

12610 CROSSED FIELD SWITCH TUBE: A REUSABLE FUSE. Harvey, R. J.; Lutz, M. A. (Hughes Research Labs., Malibu, CA). pp 670-674 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From fifth symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

The crossed field switch tube is a plasma device capable of forceably interrupting high currents (~kA) against high forward voltages (~100 kV). The basic operating principles of crossed field switch tubes are reviewed and their use as reusable fuses for inductive energy storage switching discussed. (auth)

12611 FAST, HIGH ENERGY, NON-UNIFORM FIELD DISTORTION CROWBAR SWITCH. Chen, Y. G. (Columbia Univ., New York). pp 675-678 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From fifth symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

The fast closing, high voltage, high energy nonuniform field distortion switch has been further developed for crowbar application. Two identical field distortion switches have been housed on a parallel plate transmission line to initiate and crowbar the discharge of a capacitor bank. Proper biasing of the crowbar switch trigger electrode is accomplished through an R-C voltage dividing circuit by connecting copper sulfate resistors and the trigger cable capacitances in parallel. This switch can be operated in free flowing sulfur-hexafluoride gas or air, and is able to handle 30 KJ at 80 KV. Due to simplicity and symmetry, these switches are relatively inexpensive and easily maintained. (auth)

12612 MULTIPLE CHANNEL SWITCHING IN WATER DIELECTRIC PULSE GENERATORS. Burton, J. K.; Conte, D.; Lupton, W. H.; Shipman, J. D. Jr.; Vitkovitsky, I. M. (Naval Research Lab., Washington, DC). pp 679-683 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From fifth symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

Criteria were developed for multiple channel switching without triggering of water dielectric pulse power systems. The channel-to-channel jitter time, the current partition between channels, and the mechanical integrity of the switch have been determined for switching high voltage pulse lines at energies up to 30 kJ. The operation of switches has been compared for voltages applied for 100 and 600 nsec. The results can be projected to the design of 10^{13} W pulse generators. (auth)

12613 APPLICATION OF ADVANCED TECHNOLOGY TO SUZY II. Ford, R. D.; Jenkins, D. J.; Young, M. P. (Naval Research Lab., Washington, DC). pp 684-690 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From fifth symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

The SUZY II experiment includes a hard connected 60-kV capacitor bank whose 560 kJ of energy would produce extensive damage if any single point electrical failure were allowed to occur. This paper describes the adaptations of state-of-the-art for materials and components as well as insulating, charging and switching technology, in terms of technical requirements and reliable bank operation for thousands of shots. Particular emphasis is given to the following: (a) development of vacuum potting techniques to mass produce high-quality silicone rubber electrical insulating gaskets; (b) life testing of high voltage gaskets; (c) development of assembly techniques to assure high reliability bank operation; (d) adaptation of insulation edge folding techniques to avoid flashover at the air/insulation interface; (e) applications of low-cost command triggered solid-dielectric starting switches; (f) use of chemical detonator clamp switch; (g) use of water resistors in charge and dump circuits; (h) use of high reliability capacitors; and (i) use of high strength materials in the load coil. (auth)

Wave Phenomena

12614 (IPPJ-165) COLLISIONAL ABSORPTION OF ION-ION HYBRID WAVE. Toyama, H.; Matsuura, K. (Nagoya Univ. (Japan). Inst. of Plasma Physics). Jun 1973. 10p. INIS.

The damping length of the ion-ion hybrid wave is calculated numerically in the density region of 10^{16} to 10^{17} cm^{-3} using the Langevin collision model, with the ion-ion collision frequency, the parallel wave number, and the D-T concentration ratio as the parameters. It is shown that the heating is effective even for very low collision frequencies encountered in thermonuclear plasmas. (auth)

12615 (IPPJ-170) FINITE AMPLITUDE ION ACOUSTIC WAVES IN A PLASMON GAS. Sakai, J. I.; Satsuma, J.; Yajima, N. (Nagoya Univ. (Japan). Inst. of Plasma Physics). Aug 1973. 26p. INIS.

The propagation of ion acoustic waves interacting with plasmon gas is investigated by eliminating the fast varying part from the variation of the system through an adequate averaging procedure. The decay interaction plays an important role in this process and leads to the damping or growth of the ion acoustic wave depending on the shape of the plasmon energy spectrum. The result in the linear approximation is compared with that obtained by Vedenov and Rudakov to show the incompleteness of their result. It is found that the finite amplitude ion acoustic wave in plasmon gas is subject to the KdV equation modified by two additional terms which represent the change of the phase velocity and the damping or growth of the amplitude. The comparison of the obtained decay rate with that of the electron Landau damping is also made. (auth)

12616 EXPERIMENTAL VERIFICATION OF COLLISIONLESS ELECTRON CYCLOTRON DAMPING. McVey, B.D.; Scharer, J.E. (Electrical Engineering Department, University of Wisconsin, Madison, Wisconsin 53706). Phys. Fluids 17: No. 1, 142-147 (Jan 1974).

Measurement of collisionless spatial cyclotron damping rates and finite minimum wavelengths near resonance ($0.7 \leq \omega/\omega_c \leq 1.0$) are presented for a right-hand circularly polarized wave propagating in a magnetic beach. The magnetic beach is sufficiently weak so that a WKB approximation for the spatial variation of the wave electric field is valid. It is shown that the plasma and wave satisfy conditions for which the collisionless damping process is domiant. A technique is presented which uses the wave data to determine the plasma density and temperature by means of the theoretical hot plasma spatial dispersion relation for the whistler mode. The resulting plasma parameters agree consistently for both the measured wave numbers and damping rates as well as with those obtained from Langmuir probe data. (auth)

12617 EXCITATION OF ELECTROSTATIC MODES BY MODE CONVERSION-NUMERICAL METHOD. Tang, T. (Department of Electrical and Computer Engineering, The University of Massachusetts, Amherst, Massachusetts 01002); Mani, S.A. Phys. Fluids 17: No. 1, 170-177 (Jan 1974).

The study of mode conversion between the extraordinary mode and the Bernstein mode in a warm inhomogeneous collisionless magnetoplasma is carried out numerically by solving for the Fourier transformed electric fields, using a recently developed integral formulation. Reflection and transmission coefficients for the incident extraordinary wave are obtained as functions of the peak number density for an inverse-parabolic electron density profile. In addition to previously reported resonances occurring at the total reflection, antiresonances are also found. The spatial dependence of the electric fields at these resonances is presented. (auth)

12618 ION-ACOUSTIC DISTURBANCES STIMULATED BY TRUNCATED SOURCE DISTRIBUTIONS. Jacob, J.H.; Hirshfield, J.L. (Department of Engineering and Applied Science, Yale University, New Haven, Connecticut 06520). Phys. Fluids 17: No. 1, 198-205 (Jan 1974).

Plasma disturbances resulting from a modulated non-Maxwellian ion distribution emanating into a half-space plasma are discussed. The non-Maxwellian ion distribution is formed experimentally by truncating the distribution entering an energy analyzer situated at one end of a plasma column. The lower energy ions are modulated and reflected back into the plasma. When all the ions are absorbed by the analyzer, no propagating ion disturbance is observed. On reflecting some low energy ions, an ion-acoustic wave is detected. The wave amplitude initially increases when a larger segment of the ion distribution is reflected. However, when ions with velocities comparable to the phase velocity of the wave are reflected, the wave amplitude decreases. The signal velocity of the wave is also observed to increase as a greater number of ions are reflected. A modified fluid analysis to explain the observations is presented. In the analysis care is taken to include correct nonsymmetric velocity-space source functions derived from a ballistic model. (auth)

12619 FORMATION OF ION-ACOUSTIC SHOCKS. White, R.B. (Institute for Avanced Study, Princeton, New Jersey); Fried, B.D.; Coroniti, F.V. Phys. Fluids 17: No. 1, 211-213 (Jan 1974).

The formation of an ion-acoustic shock in a numerically modeled two chamber double plasma device is investigated for a plasma of cold ions and isothermal Boltzmann electrons. An initial potential ramp applied to the driver chamber launches an ion-acoustic pulse into the target chamber which steepens into a shock. The quasisteady shock structure agrees with observed double plasma shocks. An upper limit of Mach 1.6 is observed independent of the potential ramp magnitude, in agreement with theory. (auth)

12620 POLARIZATION OF PLASMA WAVE RESONANCES IN AN AXIAL MAGNETIC FIELD. Willis, J.W.; Nickel, J.C. (Physics

Department, University of California, Riverside, California 92502). Phys. Fluids 17: No. 1, 214-221 (Jan 1974).

The splitting of the Tonks–Dattner resonances in an axial magnetic field is considered. It is found that the higher-order resonances are split and decompose into left- and right-circularly polarized modes. Experiments at higher magnetic fields are described in which the Buchsbaum–Hasegawa resonances are also observed. These resonances appear to be right-circularly polarized. (auth)

12621 DISTINCTION BETWEEN COLLECTIVE AND BALLISTIC CONTRIBUTIONS IN LOW FREQUENCY PERTURBATION IN A Q MACHINE. Watanabe, S. (Institute of Materials Science and Engineering, Yokohama National University, Yokohama, Japan); Oishi, M.; Tanaca, H. Phys. Fluids 17: No. 1, 240-244 (Jan 1974).

An experimental distinction is presented between the contributions due to the collective and ballistic modes of low-frequency disturbances excited by a grid in the equal temperature plasma of a Q machine. The collective mode (ion wave) velocity must slow down with increasing electron drift velocity, while the ballistic mode must have a constant velocity irrespective of the electron drift velocity. The ballistic mode was always overwhelmingly excited in the experiment. A small wave of rather low frequency of an ion wave nature was observed only when the electron drift velocity was close to the critical one for the ion wave instability. Experimentally, we may conclude that, in general, in Q machines the ion wave which is excited by a grid and accompanied by ion Landau damping is practically invisible, being buried in the ballistic mode in agreement with an analysis of the dielectric function and also with a computer simulation. (auth)

12622 BEHAVIOR OF BERNSTEIN WAVES PROPAGATING OBLIQUELY TO THE MAGNETIC FIELD IN A BEAM-PLASMA SYSTEM. Idehara, T.; Takeda, M.; Ishida, Y. (Department of Applied Physics, Fukui University, Fukui, Japan). Phys. Fluids 17: No. 1, 266-268 (Jan 1974).

An obliquely propagating Bernstein wave excited by a coaxial antenna is amplified by inverse Landau damping in a beam–plasma system. The perpendicular components of the phase velocity are directed inward and/or outward from the beam region, corresponding to the backward and forward waves, respectively. (auth)

12623 EXPERIMENTAL INVESTIGATION OF PARAMETRIC COUPLING BETWEEN UPPER AND LOWER HYBRID FREQUENCY. Krause, K.; Schlueter, H. (Univ., Bochum, Ger.). Z. Phys.; 266: No. 3, 177-184(Jan 1974). (In German).

Weakly ionized neon columns are excited by a microwave cavity at the upper hybrid frequency (with ratios of electron cyclotron frequency to wave frequency of about ½). Low frequency signals are observed in the range of the lower hybrid frequency. These signals are split into three branches with frequency ratios 1:2:3 and exhibit threshold behavior. The second branch is closest to the lower hybrid frequency. Similar results are obtained for helium, argon, and mercury plasmas. (GE)

12624 INVESTIGATION ON THE PLASMA OSCILLATION CAUSED BY PRIMARY ELECTRONS IN A LOW PRESSURE GAS DISCHARGE. Amemiya, H. (Inst. of Physical and Chemical Research, Wako, Japan). Sci. Pap. Inst. Phys. Chem. Res. (Jap.); 67: No. 4, 161-170(Dec 1973).

The spatial intensity profile of plasma oscillation in the negative glow region of gas discharge plasma of about 10^{-3} torr was measured. The oscillation had two maxima, and its frequency spectrum was broad and varied with the distance from the cathode. The observation of the energy distribution function showed a Gaussian broadening into both higher and lower energies. The characteristic relaxation times which were calculated from experimental data suggested a weak turbulent state in a few cm from the cathode. However, the experimental results did not agree with the quasi-linear theory. One-dimensional computer experiment was performed which showed that beam electrons were modulated in the phase space rather regularly. No stochastic diffusion in the phase space was seen. The three-dimensional property of the experiment and the fact that the number of plasma electrons in a Debye length was not so large might be the reason for disagreement of the theory and simulation. (auth)

12625 ONE DIMENSIONAL SHOCK REFRACTION AT A PLASMA-COLD GAS INTERFACE. Gerofi, J.; Messerle, H. K. (Univ. of Sydney). Z. Naturforsch.; 28a: No. 10, 1668-1675(Oct 1973).

Refraction and reflection of shock waves at a plasma/cold gas interface was studied using an rf preheated section in an electrothermal shock tube. The gas used in the experiment was argon at initial pressures from 10 to 30 torr, with initial temperature of 9000°K. A detailed numerical analysis of the refraction event was undertaken using a method that does not require definition of an effective γ. Methods that do use such a γ are not accurate, except for very weak shocks. Because of short ionization times it has been possible to assume equilibrium behind the various shock waves. Calculations suggest that in the region of interest, reflected and refracted shock velocities depend primarily on initial shock velocity, slightly on initial plasma temperature and very weakly on initial pressure. The analysis covers initial temperatures of 6000 to 12,000°K and initial pressures of 10 to 50 torr. Calculations and experimental results are presented. These show that a step function discontinuity is a good approximation to the nature of the plasma/cold gas interface in this situation. (GE)

12626 LOWER HYBRID RESONANCE AND PARAMETRIC DECAY EXCITED BY A SLOW-WAVE DEVICE. Brusati, M.; Cima, G.; Fontanesi, M.; Sindoni, E. (Univ., Milan). Lett. Nuovo Cim.; 10: No. 2, 67-72(11 May 1974).

The experiment was performed on a 200 cm length and 15 cm diameter plasma column in a (0.8 to 1.8) kG static magnetic field. The plasma, with a density ranging between (5×10^{10} to 2×10^{11}) electrons/cm^3 and an average electron temperature of 10 eV, is generated at the ends of the column by two Lisitano coils fed with S-band c.w. 500 W maximum-power each. The filling-gas pressure is varied between 5×10^{-5} and 9×10^{-5} torr. Owing to these experimental features, the LH wavelength in vacuum is longer than 300 cm, so that a quasi-static approximation is assumed. The data are described. (MOW)

12627 PROPAGATION THROUGH A TWO-DIMENSIONAL INHOMOGENEOUS PLASMA. Madan, V. P. (Red Deer Coll., Alberta); Rogers, T. D. Rev. Roum. Phys.; 19: No. 2, 161-165 (1974).

Solutions are presented for the propagation problem associated with a two-dimensional inhomogeneous plasma $\epsilon_p(x,z)$, for different types of variations. When $\epsilon_p(x,z)$ decomposes additively as the sum of two polynomials in x and z, the solution is associated with the Hermite polynomials. The effect of an interaction has also been discussed briefly while some special cases are mentioned. The mathematical treatment of this investigation, however, bears a striking resemblance with that of the atoms in wave mechanics. (auth)

12628 ANALOGY BETWEEN A WAVE PACKET OF QUASI-MONOCHROMATIC PLASMA WAVES AND A PARTICLE IN A GRAVITATIONAL FIELD. Petrzilka, V. A. (Inst. of Plasma Physics, Prague). Czech. J. Phys.; 24: No. 5, 522-526(1974).

In a cold collisionless plasma, the energy-mass relation for a wave packet propagating radially in a Schwarzschild gravitational field is equivalent to the energy-mass relation. The quasi-particle description of the wave packet yields no new red-shift formula. (auth)

12629 PARAMETRIC EXCITATION OF ALFVÉN AND ION ACOUSTIC WAVES. Lashmore-Davies, C.N. (United Kingdom Atomic Energy Authority, Culham Laboratory, Abingdon, Berkshire OX14 3DB, United Kingdom); Ong, R.S.B. Phys. Rev. Lett. 32: No. 21, 1172-1175 (27 May 1974).

The threshold is derived for parametric excitation of Alfvén waves in a uniform plasma in which the background magnetic field is modulated sinusoidally in time. Including the plasma pressure we show that ion acoustic waves can also be excited directly. Both cases are absolutely unstable for any interaction length. Finally, we analyze the subsequent decay of the excited Alfvén wave into an ion acoustic and another Alfvén wave. (auth)

ENGINEERING

Energy Conversion

Refer also to abstract 12546.

12630 CURRENT–CONVECTIVE INSTABILITY IN A NONEQUILIBRIUM MHD GENERATOR. Nedospasov, A.V.; Petrov, V.G. (Institute of High Temperatures, Academy of Sciences of the USSR). High Temp. 11: No. 1, 173-175 (Sept 1973).

We discuss a modification of the current-convective instability of a plasma. (AIP)

12631 OPTIMIZATION OF THE POWER OF FARADAY MHD GENERATORS OPERATING ON NONEQUILIBRIUM PLASMA. Vorob'ev, V.S.; Krasnov, V.I. (Institute of High Temperature, Academy of Sciences of the USSR). High Temp. 11: No. 1, 134-138 (Sept 1973).

The power of a Faraday MHD generator operating on nonequilibrium turbulent plasma is optimized for known stagnation parameters of the gas at the channel entrance, magnetic induction, and channel dimensions (length and maximum cross section). The relations between the optimal local parameters are found. The system of equations describing an extreme flow is solved numerically. Results of calculations for a mixture of helium with cesium are presented. (auth)

12632 QUALITATIVE ANALYSIS OF THE EFFICIENCY OF MHD ENERGY CONVERSION. Baranov, V.Y.; Malyuta, D.D.; Panchenko, V.P.; Ulinich, F.R. (Kurchatov Institute of Atomic Energy). High Temp. 11: No. 1, 139-144 (Sept 1973).

The region of optimal parameters is theoretically determined and estimates are given for the energy conversion factor of an equilibrium-plasma MHD generator $\gamma-1 \ll 1$. (auth)

12633 MEASUREMENT OF A PLASMA'S TEMPERATURE BY A SPECTROSCOPIC METHOD WITH CONTINUOUS AUTOMATIC DETECTION. Vasil'eva, I.A.; Kirillov, V.V.; Maksimov, I.A.; Malyuzhonok, G.P.; Novosadov, V.B. (High–Temperature Institute, Academy of Sciences of the USSR). High Temp. 11: No. 4, 749-755 (Mar 1974).

A description of a system for automatic, continuous measurement of the temperature of a plasma in a MHDG is presented. A unified method for the treatment of spectral lines is utilized. The system contains an optical circuit with a standard source, a spectral instrument with a photoelectric attachment, a calculator with an assembly for the separation of channels, and a recording device. Measurement of the temperature of the flame from a Mekker burner is conducted under laboratory conditions. Measurements of the temperature of a plasma in the ducts of large-scale MHD–generators are conducted, and the results are cited. (auth)

12634 THERMODYNAMIC EFFICIENCY OF ENERGY INSTALLATIONS WITH A TWO–PHASE MHD GENERATOR, OPERATING ACCORDING TO THE ERICSSON CYCLE. Morozov, A.E.; Postnikova, I.M.; Syas'kin, Y.M.; Shpil'rain, E.E.; Yakimovich, K.A. (High–Temperature Institute, Academy of Sciences of the USSR). High Temp. 11: No. 4, 756-761 (Mar 1974).

New cycles for energy installations with a two-phase MHDG are proposed and thoroughly analyzed. The methodology of the thermodynamic analysis of such diagrams is discussed, and it is shown that with given loss factors in the basic units of the installation the effective efficiency of the cycle does not depend on the nature of the thermodynamics and the electrodynamics of the working media. It is also shown that the optimum cycle with a two-phase MHD generator from the point of view of a guarantee of maximum efficiency is a cycle in which the overall expansion ratio is distributed in an appropriate manner between the MHD generator and a gas turbine. (auth)

12635 APPARATUS FOR TESTING DIRECT ENERGY CONVERSION OF PLASMA ENERGY TO ELECTRICITY. Barr, W. L.; Calderon, M. O.; Haratani, T. N.; Howard, B. C.; Kinney, J. D.; Moir, R. W.; Smith, R. R. (Univ. of California, Livermore). pp 126-131 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From fifth symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

The Lawrence Livermore Laboratory program for research and development of direct energy conversion for fusion reactor application is described. A new test facility consisting of a system of magnets, a vacuum chamber, and collector structure of unusual shapes and sizes is described. Under laboratory conditions, the anticipated collection efficiencies are 65% for a 2-stage venetian blind collector concept and 89 to 90% for a 22-stage periodic focussing concept. Because of space charge considerations, the venetian blind concept appears to be appropriate in the 100- to 200- keV ion energy range whereas the periodic focussing concept is more interesting in the 500- to 800-keV range. (auth)

Facilities and Equipment

Refer also to abstract 12605.

12636 (HDL-TDR-1621) STUDIES RELATIVE TO POSSIBLE LASER PUMPED BY NUCLEAR BETA RAYS. I. Optical Spectra of $LiTmF_4$ Doped with a Rare Earth Ion. Morrison, C. A.; Wortman, D. C. (Harry Diamond Labs., Washington, D. C. (USA)). Oct 1973. 32p. NTIS.

A study was made of the optical spectra of single-crystal $LiTmF_4$ doped with a rare earth ion with the objective of determining the feasibility of using this material as a nuclear pumped laser. The rare earth dopant would be pumped by the beta radiation in the nuclear decay of ^{170}Tm artificially created by bombarding the nonradioactive crystal with thermal neutrons. The optical spectra were therefore recorded before and after the crystals were irradiated by nuclear energy. The principal results of the study are given. (auth)

12637 (LA-5555-PR) AEROSOL RESEARCH AND DEVELOPMENT RELATED TO HEALTH HAZARD ANALYSIS. Progress Report, July 1–December 31, 1973. Ettinger, H. J.; Fairchild, C. I.; Ortiz, L. W. (Los Alamos Scientific Lab., N. Mex. (USA)). Apr 1974. Contract W-7405-eng-36. 23p. Dep. NTIS $4.00.

A new fibrous glass aerosol produced from a hearing protection product (Swedish Wool) was used to provide additional calibration data for the 10-mm nylon cyclone. These fibrous aerosols, characterized by the Andersen impactor, ranged from 3.3 to 5.9 μm in mass median aerodynamic diameter. Experimental data indicate best agreement with the ACGIH respirable dust curve at a sampling flow rate of 1.5 l/m, consistent with previous experimental data obtained using other fibrous test aerosols. Long-term evaluation of the permanent mounting technique for asbestos samples indicates the stability of these mounts during storage under various temperature extremes. Additional calibration data for the 10-mm nylon cyclone using polydisperse coal dusts indicate the variation in cyclone performance at flow rates of 1.7 and 2.0 l/m, and reconfirm that the better approximation to the ACGIH respirable dust curve is at 1.7 lm. Loading tests show that long-term operation (12 hours) of the cyclone results in a 10% decrease in penetration, which re-emphasizes the importance of daily cleaning of the cyclone after use. Construction of the Standard Coal Aerosol Test System was completed and the unit shipped to NIOSH, Cincinnati. The unit will produce a controlled, uniform dust cloud with mass concentrations up to 10 mg/m^3, relative humidities ranging from 10 to 90%, with a flow rate of 100 cfm. Variations in mass concentration and airflow over 80% of the chamber sampling area range from ±5 to ±12%, an improvement over the original design specifications for this system. (auth)

12638 (LA-UR-74-801) SUBTERRENE ROCK-MELTING EXCAVATION PROGRAM. Hanold, R. J. (Los Alamos Scientific Lab., N. Mex. (USA)). 1973. 19p. (CONF-7309108-1). Dep. NTIS $4.00.

From 15th symposium on rock mechanics; Custer, South Dakota, USA (Sep 1973).

The objective of the Subterrene program is to develop new, innovative systems for drilling and tunneling based on the rock-melting concept. Rocks are mixtures of minerals and therefore, melting points are relatively low. The common igneous rocks, which are especially difficult to penetrate mechanically, in general become fluid at temperatures in the vicinity of 1470°K. Refractory metals, such as molybdenum and tungsten, have melting points much higher than this and are available for the development of the required rock-melting penetrator structures. This proposed excavation method, which is relatively insensitive to variations in rock formation, produces a liquid melt whose behavior can be predicted by the laws of fluid dynamics. The basic rock heat transfer and melting processes are well defined and amenable to theoretical analyses and the rate of advance is dependent on the power supplied to the hot penetrator. The rock melt can be chilled to a glass and formed into a dense, strong, firmly attached hole lining. Thus by the use of a melting penetrator, permanently self-supporting holes can be produced even in unconsolidated sediments. (auth)

12639 COPPER VAPOR PULSE LASER WITH A REPETITION FREQUENCY OF 10 kHz. Isaev, A. A.; Kazaryan, M. A.; Petrash, G. G. Opt. Spectrosc. (USSR) (Engl. Transl.); 35: No. 3, 307-308 (Sep 1973).

Translated from Opt. Spektrosk.; 35: No. 3, 528-530(Sep 1973).

A copper vapor laser operating at an excitation pulse repetition frequency of 10 kHz gave a mean output power of 2.4 W, corresponding to a peak power of 48 kW and a specific peak power of 1.4 kW/cm^3. (auth)

12640 SPECTRAL-TIME CHARACTERISTICS OF DYE-SOLUTION LASING IN PUMPING WITH A SERIES OF ULTRASHORT PULSES. Neporent, B. S.; Kryukov, V. V.; Lukomskii, G. V.; Shilov, V. B. Opt. Spectrosc. (USSR) (Engl. Transl.); 35: No. 3, 309-311(Sep 1973).

Translated from Opt. Spektrosk.; 35: No. 3, 531-534(Sep 1973).

The spectra of a series of dye solution lasing pulses were studied under various conditions in pumping with trains of picosecond pulses from a ruby laser. It was demonstrated that the buildup of molecules in the triplet state induces a shift in the cryptocyanine lasing spectra to the red and a shift in the rhodamine spectra to the blue. (auth)

12641 SPECTRAL KINETICS OF THE LASER ACTION IN SOLUTIONS OF VARIOUS ORGANIC SUBSTANCES. Neporent, B. S.; Shilov, V. B.; Lukomskii, G. V. Opt. Spectrosc. (USSR) (Engl. Transl.); 35: No. 3, 312-314(Sep 1973).

Translated from Opt. Spektrosk.; 35: No. 3, 535-539(Sep 1973).

The red shift of the lasing spectra for solutions of Rhodamine 6G and cryptocyanine on excitation by single pulses from solid-state lasers was studied. The relaxational character of the shift is confirmed by the dependence of the magnitude of the spectral shift on the pumping power. The decisive role of intramolecular relaxations was confirmed by the preservation of the effect with a change in the viscosity and temperature of the solutions over wide ranges. This fact, and the weak role of triplet–triplet absorption, were demonstrated in earlier papers. It was also established that there is no correlation between the shift of the lasing spectra and the edge losses in the resonator. (auth)

12642 MEASUREMENT OF THE ANGULAR DIVERGENCE AND TRANSVERSE INTENSITY DISTRIBUTION OF RADIATION FROM A CO_2 LASER. Burmatov, I. F.; Vasilenko, L. S.; Shishaev, A. V. (Inst. of Semiconductor Physics, Novosibirsk, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 16: No. 6, 1779-1781(1973).

Translated from Prib. Tekh. Eksp.; 16: No. 6, 141-142(1973).

An instrument is described for measuring the angular divergence and transverse distribution of the radiation intensity of a CO_2 laser. Typical oscillograms of the intensity distribution of the radiation over the beam cross section are presented, which were obtained by means of the designed device. Measurements were carried out at the angular divergence of the radiation from a CO_2 laser with an output-aperture diameter of 3mm. The difference between the theoretical and experimental values of the divergence lies within the accuracy limits of the measurements. (auth)

12643 LASER BASED ON AN ORGANIC DYE. Alekseev, V. A.; Kozlov, N. P.; Protasov, Yu. S. (Moscow Higher Technical School). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 16: No. 6, 1774-1775(1973).

Translated from Prib. Tekh. Eksp.; 16: No. 6, 137-138(1973).

A description is given of a laser based on the organic dye rhodamine 6J which is excited by the light from the plasma focus of a pulsed plasma accelerator of the erosion type. The working vacuum in the accelerator is ~10^{-6} torr. The working substance and a liquid protective filter are pumped through the active zone of the laser. (auth)

12644 ELECTRON-BEAM-CONTROLLED-LASERS: DISCUSSION FROM THE ENGINEERING VIEWPOINT. I. Design of the 1 kJ and 10 kJ CO_2 Lasers. Stapleton, R. E.; Riepe, K. B.; Jolly, E. L. Jr.; Weinbrecht, J.; Hayden, J. J.; Ferdinand, E. O.; Carroll, T. A. (Los Alamos Scientific Lab., NM). pp 619-625 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From fifth symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

The Los Alamos Scientific Laboratory (LASL) CO_2 laser program was organized to design, fabricate, and evaluate high-energy, short-pulse CO_2 lasers for use in fusion studies. A general discussion of electron-beam-controlled lasers is included, along with details of component designs. This includes a discussion of the high voltage pulsers, electron guns, pumping chamber vessels, timing, and operational experience with the 1 kJ CO_2 laser system components. In addition, the general design of the 10-kJ CO_2 laser system is presented. (auth)

12645 ELECTRON-BEAM-CONTROLLED GAS LASERS: DISCUSSION FROM THE ENGINEERING VIEWPOINT. II. Problems in the Electrical Design of Very High Energy Systems. Riepe, K. B.; Stapleton, R. E. (Los Alamos Scientific Lab., NM). pp 626-632 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From fifth symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

Some problem areas in the design of very high energy electron-beam-controlled short pulse gas lasers are discussed. One of the prime areas of interest is the high voltage pulse generators for driving the electron gun and gas pumping. The use of pulse-forming networks for improving energy transfer efficiency is discussed. The use of thermionic cathode devices will require a large AC power installation. The properties of alternate electron sources (cold cathode and plasma cathode devices) are reviewed. The impact of laser beam energy density limitations on system geometry and electrical design is discussed last. (auth)

12646 SINGLELINE OPERATION OF A HIGH-POWER CARBON MONOXIDE CHEMICAL LASER. Hirose, Y. Urbana, Il; University of Illinois (1973). 138p. University Microfilms Order No. 74-12,042.

Thesis (Ph. D.).

An attempt to interpret the singleline operation of a high power longitudinal CO chemical laser system using the reaction of O + CS_2 which normally operates on multiline vibration-rotation transitions of CO is described. This singleline operation was observed under certain operating conditions with no frequency selective elements in the laser cavity. It is suggested that the operating conditions cause the CO–CO vibration-vibration collisional energy exchange processes to compete with stimulated emission to yield singleline operation. Experimental data and results of computations on a laser model are presented to support this suggestion. A CW power of 7 W and a chemical efficiency of 4.1% were achieved in this longitudinal system, the highest values for any system of this type reported at the present time. Also described is the atomic nitrogen initiated CW CO chemical laser from the reaction of O_2 + CS_2. Although the laser behavior is similar to that of the usual CO chemical laser system, the initiation scheme is entirely new. Possible excitation mechanisms for this laser action are presented. (Diss. Abstr. Int., B)

Heat Transfer and Fluid Flow

Refer also to abstract 14523.

12647 (FEI-394) CALCULATION METHOD OF HYDRODYNAMIC CHARACTERISTICS OF A FLOW IN A CHANNEL WITH THE NONCIRCULAR CROSS SECTION. Burakov, B. G.; Kashcheev, V. M.; Nomofilov, E. V. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk. Fiziko-Ehnergeticheskij Inst.). 1973. 25p. (In Russian). INIS.

A square channel is considered as an example of a possible method of semiempirically calculating the hydrodynamic characteristics in a channel of noncircular cross-section with secondary flows being taken into account. On the basis of an analysis of the experimental data a formula is proposed in order to determine the vorticity of secondary flows as a function of coordinate position. Examples are presented where velocity fields and tangential stresses in a square channel are calculated. (SJR)

12648 (KFK-1891) EKAPPA: A COMPUTER PROGRAM FOR THE CALCULATION OF THE STEAM ISENTROPE EXPONENTS. Analysis and Program Description. Harten, U.; Ziegler, H. J. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Reaktorbauelemente). Dec 1973. 52p. (In German). Dep. NTIS (US Sales Only) $5.75.

An easy, manageable computing program which helps to compute the isentrope exponent of steam in the wet and superheated steam state was developed. The mathematical-numerical method used is based upon thermodynamic correlations which describe the isentrope exponent. The computing program called EKAPPA meets the following requirements: adequate accuracy of the computed isentrope exponent in the superheated and wet steam state within the limits of the requirements of accuracy as contained in the VDI tables for water and steam, and compatibility of the dimensions of the parameters used with the already existing programs. (auth)

12649 (SLA-73-5975) PRESSURE AND TEMPERATURE MEASUREMENTS IN A COLD-WALL HYPERSONIC TURBULENT BOUNDARY LAYER. Peterson, C. W. (Sandia Labs., Albuquerque, N. Mex. (USA)). 1973. 17p. (CONF-740613-2). Dep. NTIS $4.00.

From Heat Transfer and Fluid Mechanics Institute conference; Corvallis, Oregon, USA (12 Jun 1974).

Pitot pressure, cone-static pressure, and total temperature surveys have been made in a cold-wall hypersonic turbulent boundary layer in order to assess the validity of current prediction techniques and to identify the fundamental physical properties of turbulence in such high-speed flows. Wall static pressure and surface temperatures were measured at several locations ahead of the survey stations to characterize the upstream history of the flow. These data show that the spatial distributions of velocity, temperature, and density across the boundary layer are strong functions of the upstream wall temperature history, contrary to the assumptions implicit in most hypersonic turbulent boundary layer calculation procedures. However, wall temperature history has a negligible effect upon the velocity-temperature correlation which is often used in lieu of a turbulent energy equation. Mach number, static pressure, and Pitot pressure distributions are also unaffected by wall temperature history effects, but present measurements indicate that these mean flow properties may be influenced by the upstream pressure history. Significant variations in static pressure were measured across the boundary layer; two possible causes of this observation are discussed. In view of these experimental results, suggestions for improving present flow modeling and calculation techniques are presented. (auth)

12650 STRUCTURE OF TURBULENT FLOW IN TRIANGULAR ARRAY ROD BUNDLES. Trupp, A. C. Winnipeg, Manitoba; Univ. of Manitoba (1973). National Library of Canada, Ottawa.

Thesis (Ph. D.).

An experimental study of fully developed uniform-density turbulent flow through triangular array rod bundles is described. The pitch-to-rod diameter (P/D) ratios were 1.20, 1.35 and 1.50, and the Reynolds number range was 12,000 to 84,000. Based on the equivalent hydraulic diameter concept, friction factors were found to be functions of both Reynolds number and P/D ratio. Local wall shear stress variations were much smaller than predictions ignoring secondary flow, and the maxima did not occur at the positions facing the subchannel centerline. Spatial-distributions of the mean axial velocity when scaled on the bulk average axial velocity, were substantially independent of Reynolds number and P/D ratio, but the radial distributions were modified forms of the universal logarithmic laws. Attempts at direct measurement of the secondary velocities were unsuccessful, however the secondary flow pattern (common to the three P/D ratios) was inferred from the available evidence. The order of magnitude of the secondary velocities were indicated to be probably less than ½% of the bulk average axial velocity. The turbulence data were found to scale only fairly well on the average friction velocity. The normalized radial distributions of the normal stresses and the primary shear stress (ρuv) were fairly similar to the distributions for fully developed pipe flow. The experimental data also include the shear stress ρuw, one-dimensional (axial) power spectra and the Taylor microscale. Using the experimental data, calculations were made for the mean turbulent kinetic energy, eddy diffusivities, and the approximate mean energy balance. A literature review and developments of the fluid-mechanical equations are also included. (Diss. Abstr. Int., B)

12651 STUDY OF TWO-PHASE FLOW WITH CHEMICAL REACTION IN RIFLED TUBES. Zarnett, G. D. Toronto; Univ. of Toronto (1972). National Library of Canada, Ottawa.

Thesis (Ph. D.).

An analysis of mass transfer with a chemical reaction in horizontal two-phase gas-liquid flow is presented. The mass transfer systems studied were CO_2 gas and a CO_2-N_2 mixture for absorption into water and aqueous diethanolamine (DEA) solutions. The velocity ranges investigated are 0.600 to 2.220 ft./sec. for the liquid and 0.11 to 8.52 ft./sec. for the gas. The conduits used in the experiments were smooth ¾ inch ID Lucite tubes, two of which were fitted with $\frac{1}{8}'' \times \frac{1}{4}''$ spiral ribs throughout the tube length with pitch-to-diameter ratios of 1.57 and 2.79. The generation of swirl flow in pipelines by the use of internal spiral ribs results in the formation of several new flow patterns when used with two-phase gas-liquid flow. The main effect of this "rifled tube" is its ability to cause the gas to move away from the upper wall of the tube and flow in the central core. In turn, the resulting increase in interfacial area has a pronounced effect on carbon dioxide mass transfer with and without chemical reaction between the phases. Thus, the effects of rifled tubes on mass transfer were correlated using the system parameters of velocities, densities, viscosities, temperature and pressure. The use of these correlations is discussed for the design of rifled tubular reactors. (LCL)

12652 HEAT TRANSFER TO A Na–K ALLOY IN A CLOSE-PACKED ROD ARRAY WITH MIXED CONVECTION. Kolyaskin, V.I.; Kudryavtseva, L.K.; Ushakov, P.A. (Physico-energetics Institute, Obninsk). High Temp. 11: No. 4, 701-705 (Mar 1974).

The apparatus and methods are described, and results are given for the temperature distribution and heat transfer under various flow conditions and flow directions for a Na–K alloy. A considerable increase in Nu is obtained for $Pe \lesssim 100$ and parallel mixed convection, this being relative to purely forced motion. A formula is given to evaluate the magnitude of the effect. It is shown that for $Pe < 100$ and countercurrent mixed convection, the heat transfer at large values of $Gr \cdot Pr^2$ is appreciably less than that in forced convection. (auth)

Materials Testing

Refer also to abstracts 12672 and 14564.

12653 (INIS-mf-996) HIGH-ENERGY IRRADIATION DEVICES FOR INDUSTRIAL RADIOGRAPHY OF THICK STEELS. Bonazzo, E. (Finanziaria E. Breda S.p.A., Milan (Italy)). Mar 1973. 19p. (In Italian). INIS.

From 18th nuclear congress; Rome, Italy (26 Mar 1973).

A general survey of high-energy radiation systems for industrial radiography is presented. The radiography test problems are examined for high-thickness steel structures as required for nuclear power plants applications. The physical characteristics of RX devices, radioisotope equipment, betatrons, and linear accelerators are discussed. Problems connected with personnel protection are also examined. (INIS)

12654 RADIATSIONNAYA DEFEKTOSKOPIYA. (Radiation Defectoscopy). Rumyantsev, S. V. Moscow; Atomizdat (1974). 512p.

The first section comprises four chapters, and deals with the physics of ionizing radiation, interaction of ionizing radiation with matter, counting ionizing radiation, and various sources of ionizing radiations. The second section contains chapters on the sensitivity of the radiographic method, determining the position of a defect, controlling the exposure, methods of image formation (converters and intensifiers), control of weld quality, the effect of pores and cracks on strength, radiation thickness meters, and safety techniques to be used in radiation defectoscopy. (SJR)

Nuclear Explosions

Refer also to abstract 12687.

12655 (AD-761580) IDENTIFICATION OF EARTHQUAKES AND UNDERGROUND EXPLOSIONS. Semiannual Report. Herrin, E. (Southern Methodist Univ., Dallas, Tex. (USA)). Feb 1973. 33p. (AFOSR-TR-73-1003). NTIS $3.00.

Progress of research made for the first six months of FY 1972 to 1973 is reported. The research has been concentrated in several areas. Investigations of Rayleigh wave dispersion over a continental path have shown a dispersion wave stability that has enabled the development of "chirp" (or matched) filter techniques. When suitably constructed these filters permit the detection of surface waves with low signal-to-noise ratios, and enable the separation of mixed events. Array processing techniques in frequency-wave-number space have been significantly improved. A method has been described for correcting the bias in the estimation of body wave magnitudes (m_b). Finally, two-dimensional model studies have been used to corroborate theoretical predictions of surface wave spectra for an oceanic upper mantle model. (auth)

12656 (SLL-74-232) PLOWSHARE PROGRESS REPORT FOR QUARTER ENDING MARCH 31, 1974. (Sandia Labs., Albuquerque, N. Mex. (USA); Sandia Labs., Livermore, Calif. (USA)). May 1974. Contract AT(29-1)-789. 5p. Dep. NTIS $4.00.

Plowshare Project activities are reported and included: preliminary electrical compatibility testing of the arming and firing components; development of control switches; investigation of destruct system, and modification of a safe-secure trailer. (LCL)

12657 (TID-26586) PROGRESS AND PROBLEMS IN DEVELOPING NUCLEAR AND OTHER EXPERIMENTAL TECHNIQUES FOR RECOVERING NATURAL GAS IN THE ROCKY MOUNTAIN AREA. (General Accounting Office, Washington, D. C. (USA)). 1973. 85p. Dep. NTIS $7.25.

Nuclear stimulation, hydraulic fracturing, and chemical explosive fracturing are methods under study for increasing the

recovery of natural gas. Large amounts of natural gas, approximately 12 times the 1972 US domestic gas recovery, are located in low-permeability geological formations in the Rocky Mountains. Information is presented on the estimated wellhead cost of Rocky Mountain area gas using hydraulic fracturing or nuclear stimulation; other factors which could have an effect on the commercial development of gas in that region; and problems which remain to be solved. This information should help the Congress in considering funding levels for Federal programs for developing gas stimulation techniques and in deliberations on the nations energy problems. (LCL)

12658 (UCID-16078) SPALL MEASUREMENTS PROGRAM FOR RIO BLANCO. Toman, J.; Terhune, R.; Sisemore, C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jul 1972. Contract W-7405-eng-48. 23p. Dep. NTIS $4.25.

A Rio Blanco Event instrumentation plan is proposed which is designed for the purpose of measuring the depth of spall, i.e., tensile failure of rock, directly above the detonation point, of determining the limit of the subsurface spall zone, and of measuring the horizontal extent of the shallow surface spall zone. It is recommended that three instrument wells up to 900 ft-deep and containing six instrument locations be used to insure survival of the subsurface instrumentation and cables, that additional instrument holes be placed at ranges of about 3000 to 7000 ft along a radial line to establish the shape of the spalled zone, and that surface accelerometers spaced out to an 18,000 ft radial distance would complete the system. (LCL)

12659 TREATY ON THE NON-PROLIFERATION OF NUCLEAR WEAPONS. Treaty Series 1973, No. 3. Canberra, Australia; Australian Government Publishing Service (1973). 5p.

The text of the treaty on the non-proliferation of nuclear weapons (to which Australia is a signatory) is given. (AT)

12660 TREATY ON THE PROHIBITION OF THE EMPLACEMENT OF NUCLEAR WEAPONS AND OTHER WEAPONS OF MASS DESTRUCTION ON THE SEA-BED AND OCEAN FLOOR AND IN THE SUBSOIL THEREOF. Treaty Series 1973, No. 4. Canberra, Australia; Australian Government Publishing Service (1974). 4p.

The text of the treaty on the non-proliferation of nuclear weapons (to which Australia is a signatory) is given. (AT)

12661 TELESEISMIC SOURCE PARAMETERS OF THE LONGSHOT, MILROW, AND CANNIKIN NUCLEAR EXPLOSIONS. King, C.; Abo-Zena, A.M.; Murdock, J.N. (Earthquake Mechanism Laboratory, NOAA, San Francisco, California 94105). J. Geophys. Res. 79: No. 5, 712-718 (10 Feb 1974).

Teleseismic P wave spectral ratios in the frequency band 0.2–3.5 Hz between the Longshot, Milrow, and Cannikin nuclear explosions detonated under the Amchitka Island can be explained well on the assumption that each source consists effectively of three P phases (direct, pP, and slapdown) with the following parametric values: the source radii are 0.4, 0.6, and 0.9 km for Longshot, Milrow, and Cannikin, respectively; the relative source pressure steps are 1, 2.3, and 3.7; the pP–P time intervals are 0.49, 0.81, and 1.12 s; and the slapdown–P time intervals are 0.87, 1.35, and 1.85 s. The amplitudes of the pP and the slapdown phases are estimated to be 0.3–0.5 times the corresponding P amplitudes. The source radius, source pressure, pP-P time interval, and slapdown–P time interval all increase linearly with the depth of burial. The apparent average overburden P wave velocities computed from the known depth and the estimated pP–P delays are 2.9, 3.1, and 3.3 km/s, respectively. These values are approximately 15% lower than the velocities obtained from on-site measurements, indicating a velocity reduction for the surface-reflected P waves in the inelastic source region. The quantity of source pressure times the cube of the source radius apparently increases linearly with the yield. (auth)

Safety Engineering

12662 (NVO-410-21) CROSS-INDEX TO AEC-PRESCRIBED INDUSTRIAL SAFETY CODES AND STANDARDS. (Reynolds Electrical and Engineering Co., Inc., Las Vegas, Nev. (USA)). Jan 1974. Contract AT(26-1)-410. 750p. Dep. NTIS $40.50.

Pertinent items from two hundred and seventy-odd industrial safety codes and standards prescribed by the Atomic Energy Commission are contained in this Cross-Index. A library of these codes is maintained in the REECo Industrial Safety and Fire Protection Office. The Cross-Index was developed to simplify reference to specific items in the rapidly growing list of industrial safety codes and standards. As the name implies, it is primarily concerned with industrial operations, including construction; industrial hygiene, radiation, and fire protection items are included only as they appear in the prescribed industrial codes and standards. (RCK)

Vacuum Engineering

12663 CHARACTERISTICS, ADVANTAGES, AND POSSIBLE APPLICATIONS OF CONDENSATION CRYOPUMPING. Benvenuti, C. (CERN-ISR, 1211 Geneva 23, Switzerland). J. Vac. Sci. Technol. 11: No. 3, 591-598 (May 1974).

A few years ago, serious doubts were raised about the possibility of obtaining very low pressures by means of condensation cryopumping. In fact, the equilibrium pressure of condensed H_2 was found, in various laboratories, to deviate from the Clausius–Clapeyron law below about 3 K and to reach a temperature independent value ranging from 10^{-11} to 10^{-9} Torr. This phenomenon has since been investigated and clarified such that H_2 saturation pressures as low as 10^{-14} Torr have been obtained in our laboratories. In parallel, a drastic improvement of the cryogenic aspect of cryopumping has made it possible to achieve the very high pumping speeds characterizing this pumping technique while still keeping the operating cost very low. The performance of a few cryopumps made at CERN will be presented and critically compared to those of pumps of different types. Although developed for extremely low pressures (below 10^{-11} Torr), we will show that these cryopumps could be advantageously used for higher pressure applications. (auth)

ENVIRONMENTAL AND EARTH SCIENCES

Minerals and Ores

Refer also to abstract 12206.

12664 (GJO-7403) SURVEY OF NONMARINE CRETACEOUS SEDIMENTS OF NEW JERSEY, DELAWARE, AND MARYLAND AND THEIR URANIUM-BEARING POTENTIALS. Jordan, R. R. (Delaware Geological Survey, Newark (USA)). Jun 1970. Contract AT(30-1)-4087. 63p. Dep. NTIS $6.25.

Results are reported from a survey of the uranium-bearing potentials of the nonmarine Cretaceous units of the Atlantic Coastal Plain in Maryland, Delaware, and New Jersey. It was concluded that the large quantities of fluvial sandstone, the age of the deposits, and the presence of considerable organic debris, especially in the Arundel, Raritan, and Magothy formations, and similarities to the uranium-producing sandstones of the Colorado Plateau suggest that the Coastal Plain deposits may be worthy of further investigation for uranium. Negative factors are the seeming lack of source rocks and the combination of tectonics and hydrology that were so effective in the Plateau. The analogy, nonetheless, appears sufficiently strong to warrant further investigation, at least through a detailed investigation of an organic-rich horizon. (auth)

12665 (GJO-7405) PERMO-CARBONIFEROUS DEPOSITIONAL ENVIRONMENTS AND RADIOACTIVITY IN EASTERN UNITED STATES. Ferm, J. C.; Galloway, M. C. (South Carolina Univ., Columbia (USA). Dept. of Geology). 31 May 1971. 81p. Dep. NTIS $7.25.

Most uranium deposits occur in fluvially deposited Mesozoic and Tertiary sandstones in the western United States and in Tertiary deltaic sandstones of the Texas Gulf Coastal Plain. These deposits are associated with tuffaceous rocks which may have provided a source for uranium and contain woody organic material which apparently provided a site for the precipitation of uranium compounds. Although Permo-Carboniferous rocks of eastern United States have long been known to be of fluvial or deltaic origin, recent developments in environmental diagnosis have led to a much sharper definition of the relationships between rock types and specific environments. This knowledge has made possible relatively detailed mapping of depositional units and a better understanding of the source rocks from which these sediments were derived. The present analysis of the Permo-Carboniferous rocks of eastern United States shows a complete range of depositional environments from offshore marine to alluvial. In some parts of the sequence, all of these environments were formed in an oxidizing setting whereas, in other parts, an essentially oxidizing offshore province was separated from a reducing fluvio-deltaic zone by a major beach barrier system. All of the fluvio-deltaic sediments contain at least some volcanic detritus and organic woody matter is generally common. Most of these rocks, at least before intense compaction, are sufficiently permeable to permit transmission of ore bearing fluids. Although no significant quantities of uranium are now known in the Appalachian Permo-Carboniferous, some possible prospective areas are indicated in central and eastern West Virginia, eastern Pennsylvania, easternmost Kentucky and north central Alabama. (auth)

12666 (TID-26582) MAGNETIC SUSCEPTIBILITY AND GEOCHEMICAL RELATIONSHIPS AS URANIUM PROSPECTING GUIDES. Ellis, John R.; Austin, S. R.; Droullard, R. F. (USAEC Grand Junction Office, Colo. (USA). Resource Investigation Div.). Nov 1968. 24p. Dep. NTIS $4.25.

Select chemical and physical variables for 48 observations along a Wyoming ground traverse are compared statistically by use of a correlation program written for the IBM 1401. A comparison of the airborne gamma spectrometry with the ground data is also presented. Highly significant correlations exist between U_3O_8 or eU_3O_8 and eTh, eK, loss on ignition, and a significant correlation with combined P and V. Magnetic susceptibility has a slightly significant correlation with Fe, Mn and negatively with eU_3O_8. The negative correlation with uranium offers a possible prospecting method to delineate areas favorable for uranium. (auth)

12667 SYSTEMATICS OF THE GEOLOGICAL INVESTIGATION OF URANIUM IN SEDIMENTARY EARTHS. Castanon, A.; Santoma, L. (Junta de Energia Nucleare, Madrid). Energ. Nucl. (Madrid); 17: No. 83, 231-239(1973). (In Spanish).

An attempt is made at the systematization of a series of criteria relative to the prospection and study of uranium ore deposits in sedimentary earths. Four phases are established for the creation of a methodology: selection of large areas, selection of local areas, approximation to the deposit, and location of the deposit. Each of these phases is described schematically in order to stress the essential points. (tr-auth)

12668 EL NOPAL URANIUM DEPOSIT IN SIERRA DE PENA BLANCA, CITY OF ALDAMA, STATE OF CHIHUAHUA. Rubio, R. M. Mexico City; Universidad Nacional Autonoma de Mexico (1973). 99p. (In Spanish).

Thesis.

Aerial explorations located the "El Nopal" deposits in the northern part of the Sierra de Peña Blanca. The geography and the regional, area, and deposit geology are described in detail. (JSR)

12669 URANIUM DEPOSITS IN CANADA: THEIR EXPLORATION, RESERVES, AND POTENTIAL. Little, H. W. (Geological Survey of Canada, Ottawa). Can. Mining Met. Bull.; 67: No. 743, 155-163(Mar 1974).

Currently, exploration in Canada for uranium has reached its lowest level since the period from 1955 to 1965. Because of anticipated large demand for uranium in the 1980's, there is concern that exploration should be accelerated now in order to meet that expected demand. Estimates of reserves and resources of uranium in Canada were first published in 1964 and, as a consequence of exploration between 1966 and 1971 inclusive, were revised upward in 1970 and 1972. Concepts of uranium potential in Canada, based on type of deposit and geological environment, were first published in 1958, and several papers were published subsequently as these concepts became more refined and more of the essential basic geological data became available. In this paper, many belts, zones and basins are examined and assessed for their potential relative to one another, based on geological data. Logistics are also considered, although these are less of an economic factor than for base metals. (auth)

12670 DATA PROCESSING TECHNIQUES FOR THE RADON METHOD OF URANIUM EXPLORATION. Soonawala, N. M. (McGill Univ., Montreal). Can. Mining Met. Bull.; 67: No. 744, 110-116(Apr 1974).

The radon method of exploration for uranium offers the advantage of increased depth penetration when compared with the alternative, the gamma survey. Equipment of satisfactory performance is commercially available. With normal field procedures a fairly fast rate of survey can be obtained. Proper interpretation techniques give consistent, repeatable results, as is illustrated by a case history given in this paper. Preliminary interpretation is done by smoothing of the data by the method of moving averages, and the levels of significance are judged by statistical analysis. The latter analysis yields multiple normal populations in mineralized areas. (auth)

12671 ARGON-36 FROM NEUTRON CAPTURE BY CHLORINE IN NATURE. Sinclair, D. E.; Manuel, O. K. (Univ. of Missouri, Rolla). Z. Naturforsch.; 29A: No. 3, 488-492(Mar 1974).

Argon analysis on samples of sodalite from Dungannon, Ontario reveals an excess of ^{36}Ar from neutron capture on ^{35}Cl and excess ^{40}Ar from the decay of ^{40}K. These results indicate an average production rate of 5.6×10^3 atoms of ^{36}Cl per year per gram of chlorine over the age of the mineral, 3.9×10^8 yr. The surface residence time of chlorine-rich rocks may be determined from the amounts of ^{36}Ar which accumulate during the time period of exposure to cosmic rays. (GE)

12672 INVESTIGATION INTO THE SPATIAL DISTRIBUTION OF URANIUM IN ITS DAUGHTER PRODUCTS IN EXOGENOUS ORES BY FRAGMENT-RADIOGRAPHY TECHNIQUE. Kashirtseva, M. F.; Mikhailov, N. A. Razved. Okhr. Nedr; No. 9, 15-18(1973). (In Russian).

Problems in studying the dispersion of uranium and its decay products are discussed. A research method based on the use of fission fragment radiography is presented. (tr-auth)

12673 POSSIBLE SOURCE OF ORE MATTER OF URANIUM FLUORITE DEPOSITS. Shatkova, L. N.; Shatkov, G. A. Geol. Rud. Mestorozhd.; 15: No. 4, 36-43(Apr 1973). (In Russian).

A study was made of the contents of radioactive elements, chlorine, and fluorine in the acid volcanic rocks, which include the urano-fluorite ores, in a crater. The crater is located in an ancient central massif, folded with Proterozoic gneiss, crystallized shale, and Early Paleozoic granites. The crater was formed by Mesozoic tectonomagmatic activation. The content and dispersion

of the elements in the acid volcanic rocks was found to be due not only to the composition of the initial magmatic melts but also to crystallization, degassing, and high-temperature devitrification. Feisitization of the acid lava and ignimbrites, which occurred close to the surface at temperatures around 600°C, resulted in loss of ⅔ of the uranium, ¼ of the fluorine, and almost all the chlorine. The amount of thorium did not change. It is suggested that up to 25 thousand tons of uranium was lost from 1 km^3 of ignimbrites. Considering the large ignimbrite thickness and the crowns of liparites, the latter are considered as possible sources of the ores in urano-fluorite deposits. This fact should be used in exploring for and predicting uranium deposits. (tr-INIS)

Radioactive Effluents

Refer also to abstracts 12714, 14585, 14605, 14683, and 14684.

12674 (BNWL-tr-122) COST-BENEFIT METHODS IN THE SECTOR OF HEALTH PHYSICS. Bresson, G.; Fagnani, F.; Morlat, G. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 10 Jun 1974. Translation of paper SM-184/29. (CONF-740529-4). 19p. Dep. NTIS $4.00.

From seminar on radiological safety evaluation of population doses and application of radiological safety standards to man and the environment; Portoroz, Yugoslavia (20 May 1974).

A cost-benefit analysis constitutes an auxiliary method towards a decision that has been used in various economic and social sectors with varying success. Regardless of the application locale, it leans on a certain number of general principles and on simplifying hypotheses. If these principles appear relatively clear when the problem is looked at on the level of company, since any decision in this realm can be analyzed from the standpoint of its results in financial or profit terms, this is no longer so on the level of a much larger problem that goes beyond this institutional nature. Radiation safety falls to a degree into this latter category. Certain problems of radiation safety can be conceived at the level of the production unit itself (e.g. a power plant). On a general plane, it seems difficult not to include in a formulation of the problem the existence of outside groups and institutions that not only are not under the control of the authority in charge of production, but which may actually be opposed to it: neighbors of the sites and workers in production units. Independently of the physical extent of the analysis in the sense described before, another dimension must also be established depending on the intended depth of any analysis of the consequences of possible decisions. One may be more or less ambitious in the description of these consequences and go back more or less in their system of causality. Different quantification methods correspond to these different ambitions, from a complete evaluation in terms of finances to the simple quantification of consequences in physical terms. The relationships which can be analyzed between these methods, their difficulties, and the results which can be achieved are discussed in a general manner and illustrated with an example, that of the radiation safety of workers in an uranium ore extraction plant. (CH)

12675 (IRS-S-3) RADIOACTIVE DISCHARGES: ANSWERS TO PROF. BECHERT. Franzen, L. F.; Merton, A. (Institut fuer Reaktorsicherheit der Technischen Ueberwachungs-Vereine e.V., Koeln (F. R. Germany)). Dec 1971. 6p. (In German). INIS.

To Prof. Bechert's objections concerning radioactive discharges from nuclear power plants, especially the risk of ^{85}Kr, it is pointed out that the measured population dose from nuclear technology lies well below 1 mrem/a in the FRG and is practically insignificant compared with the natural population dose which amounts to from 100 to 150 mrem/a whole-body dose in the FRG, and a noticeable radiation dose from krypton or more generally rare gas discharges above the stack of nuclear power plants is not given for the population because of the safety techniques (delay lines, filters, adsorption parts). (GE)

12676 (IRS-S-4) ENVIRONMENTAL EFFECT OF NUCLEAR ENERGY: SOCIAL RESPONSIBILITY OF SCIENTISTS. Merton, A. (Institut fuer Reaktorsicherheit der Technischen Ueberwachungs-Vereine e.V., Koeln (F. R. Germany)). Dec 1971. 6p. (In German). INIS.

Critical comment is presented on a resolution (formulated by Sternglass and Gillberg) of the Annual Meeting of the "Society of Social Responsibility in Science", on the subject of "International Pollution Control" which was held at Trondheim from August 26 to 28, 1971. (GE)

12677 (IRS-S-8) RADIOACTIVE DISCHARGES: FURTHER DISCUSSION WITH PROF. BECHERT. Heim, K.; Merton, A. (Institut fuer Reaktorsicherheit der Technischen Ueberwachungs-Vereine e.V., Koeln (F. R. Germany)). Dec 1972. 14p. (In German). INIS.

The objections of Prof. Bechert to increased genetically significant radiation doses by the discharge of Kr isotopes including their decay products, in particular ^{85}Kr, during the operation of nuclear power plants and reprocessing plants, are rationally disproved. (GE)

12678 SAFETY FROM ENVIRONMENTAL RADIOACTIVITY. Ichikawa, R. (National Inst. of Radiological Sciences, Chiba, Japan). Genshiryoku Kogyo; 19: No. 9, 26-30; 49(Sep 1973). (In Japanese).

The problem of environmental radioactivity in nuclear installations concerns the radionuclides released into environment, which results in the eventual exposure of human beings to radiation. Various aspects in this connection are described: personal exposure and group exposure; exposure due to the atmospheric discharge of radioactivity; exposure due to the discharge into water-system of radioactivity; exposure due to deep-sea disposal; and power demand in the world and radiation exposure of humanity in future. With the recent increase in the capacity of nuclear power plants, it becomes important to consider the human group exposure, not only the personal exposure. Atmospheric radioactivity comes mainly from nuclear power plants and fuel reprocessing facilities; and exposure occurs in the vicinity of such sites. Water-system radioactivity affects fisheries. In the deep-sea disposal, there is the population dose commitment aspect. (JA)

12679 USE OF RIVERS TO PREDICT ACCUMULATION IN SEDIMENT OF RADIONUCLIDES DISCHARGED FROM NUCLEAR POWER STATIONS. Plato, P. (Univ. of Michigan, Ann Arbor). Health Phys.; 26: No. 6, 489-496(Jun 1974).

The liquid discharge characteristics, which include flow rate, suspended solids content, and radioactivity of the Donald C. Cook and Palisades nuclear power plants are similar to those from the St. Joseph and Black rivers, respectively, in southern Lake Michigan. The areas of influence of the rivers on Lake Michigan are defined by direct measurement of the accumulation of fallout ^{137}Cs in the sediments near the mouths of the rivers. The areas of influence of the rivers are used to predict the areas of influence expected near the two nuclear power plants after two decades of discharging radioactive wastes into Lake Michigan. (auth)

12680 POLLUTION AND PROTECTION OF SEAS AND BEACHES. Le Faucheux, O. (Centre National pour l'Exploitation des Oceans, Paris). pp 81-122 of Pollution et Protection des Mers et des Plages. Avargues, M. (ed.). Paris; Guy Le Prat (1971).

Marine pollution from large-scale use of industrial products, such as chemicals, pesticides, and detergents, is discussed. Pollution caused by maritime activities, such as the transportation of hydrocarbons and submarine mineral and petroleum exploitation, is discussed, and the consequences of various pollutants are described. Means of combatting hydrocarbon pollution are considered, including international regulations and curative measures. Also discussed are pollutants resulting from industrial activities, fluvial deposits, nuclear wastes, and military materials. The effects of hydrocarbons, detergents, organic materials, heavy metals, thermal wastes, solid wastes, and radioactive materials on the marine environment are discussed. (Pollut. Abstr.)

12681 FRESH WATER POLLUTION. 2. Radioactive Pollutants. New York; MSS Information Corp. (1973). 226p. $15.00.

Radioactivity measurements in surface waters, monitoring methods, measuring methods, and biological effects of radioactive waste are discussed. The radioactivity measurements examine the gross radioactivity in surface waters of the U. S., the environmental levels of radioactivity at AEC installations, and the radioactivity in surface waters of California and New York. Monitoring and measuring methods include ^{3}H surveillance systems, the determination of accuracy and precision limits for ^{3}H, and radioactivity measurements of ^{90}Sr, ^{134}Cs, and U. (Pollut. Abstr.)

Radioactivity Monitoring and Transport

Refer also to abstract 12678.

12682 (BNWL-SA-4834) RECOMMENDED METHODOLOGY FOR ENVIRONMENTAL SURVEILLANCE. Denham, D. H. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). [nd]. Contract AT(45-1)-1830. 11p. (CONF-740406-14). Dep. NTIS $4.00.

From second AEC pollution control conference; Albuquerque, New Mexico, USA (16 Apr 1974).

Battelle-Northwest, through the U. S. Atomic Energy Commission, Division of Operational Safety, is developing information which could be used in an AEC Handbook on Environmental Monitoring. In the first phase of the program the existing effluent and environmental monitoring practices at AEC facilities were reviewed and the capabilities of environmental monitoring programs in current use at AEC facilities are summarized. A number of non-uniform practices exist relative to environmental surveillance; examples to be discussed include sampling rationale, sampling methods, sample preparation and analysis, and data handling and interpretation. Detailed radioanalytical procedures, however, are not included. (auth)

12683 (DPSP-57-25-15(Del)) HEALTH PHYSICS REGIONAL MONITORING SEMIANNUAL REPORT, JULY–DECEMBER 1956. Mealing, H. G. Jr. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. (USA). Atomic Energy Div.). 27 Jun 1957. 38p. Dep. NTIS $5.00.

Radioactive contamination from both plant operations and bomb fallout was detectable throughout most of the period from July 1956 through December 1956. As compared to the previous report period, radioactive bomb fallout was more noticeable during this period. (auth)

12684 (DPSP-58-25-38(Del)) HEALTH PHYSICS REGIONAL MONITORING SEMIANNUAL REPORT, JANUARY–JUNE 1958. Harvey, R. S.; Horton, J. H.; Mealing, H. G. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. (USA). Atomic Energy Div.). 9 Jan 1959. 44p. Dep. NTIS $5.25.

Radioactivity from bomb fallout and plant operations was detected in environmental samples collected during January 1958 through June 1958. Radioactivity deposited on the Plant site in fallout from weapons tests was estimated to be approximately one-third as much as during the previous 6-month period. Except for tritium released from Buildings 232-F, 232-H, and 234-H stacks, Plant contributions to environmental radioactivity decreased. (auth)

12685 (DPSP-63-25-10(Del)) HEALTH PHYSICS ENVIRONMENTAL MONITORING SEMIANNUAL REPORT, JULY–DECEMBER 1962. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. (USA). Atomic Energy Div.). Jun 1963. 35p. Dep. NTIS $4.75.

Radioactivity in the environs of the Savannah River Plant was measured during the six-month period ending December 1962. Data are presented on: 1962 releases from separator areas and reactor areas; ^{131}I and beta releases to the atmosphere: effects of weapon testing fallout on atmospheric radioactivity measurements; and radioisotopes in the environment attributed to radioactive waste handling facilities. The ^{51}Cr releases throughout 1962 were substantially higher than those experienced previously. SRP operations had little effect on the alpha activity in surface waters and no effect on the chemical quality of Savannah River water. (LCL)

12686 γ-RADIATION FIELD OVER AN INFINITE PLANE SOURCE SEPARATED BY AN INACTIVE STRIP. Osanov, D. P.; Tissen, M. Yu.; Ryadov, V. G. Sov. J. At. Energy (Engl. Transl.); 34: No. 1, 42(Jan 1973).

Translated from At. Energ. (USSR); 34: No. 1, 33(Jan 1973). This is a summary of paper No. 639/6627 with full copy held at TIC.

In case of extensive radioactive contamination it becomes particularly important to make use of decontaminated strips, areas, etc. As an example of such, a deactivated strip can serve a passage cut through a contaminated territory by removing a surface layer of soil or a river whose water becomes gradually less and less active. Such an inactive strip can also be used for radioactive exploration in which the dose rate and activity density over the contaminated territory must be determined from the measured exposure rate over an artificial passage or river. To solve these problems we have determined quantitative relationships between the exposure dose rates over contaminated land and deactivated strip. To compute the quantitative relations we have used expressions derived earlier. The final results allow for multiple scattering of γ-radiation in air using a method described earlier as well as the effect of air–soil interface. All calculations were made for a γ-radiation energy of 0.8 MeV corresponding to the average γ-radiation energy of prompt fission products of approximately 10 h age. The results are shown as the ratio of dose rate P_0 over an infinite active plane to the dose rate P_1 at various points over an inactive strip and to the dose rate P_2 at various points of a semi-infinite plane adjoining the inactive strip. The dose rate was measured in air at a height 1 m over the soil surface. (auth)

12687 DECAY CHARACTERISTICS OF BETA-ACTIVITY OF THE HOT PARTICLES DUE TO THE NUCLEAR TEST EXPLOSIONS. Tatewaki, T. (Shinshu Univ., Nagano, Japan). Shinshu Daigaku Kogakubu Kiyo; No. 33, 15-25(Dec 1972). (In Japanese).

Measurements of the gross beta-activity were made for the hot particles (highly radioactive fallout particles) due to the third, the fifth and the seventh Chinese nuclear test explosion. The rate of beta decay of the hot particles was investigated on the assumption that its rate was given by the equation $I = Ct^{-\alpha}$ based on the Way-Wigner equation. The characteristic decay curves of beta activity of the individual hot particles were shown as straight lines on logarithmic graph paper with the measured values of the elapsed time t after the nuclear test explosion and the corresponding beta activity I as co-ordinates, and those of the groups of the individual hot particles due to each of the Chinese nuclear test explosions mentioned above were similarly shown as straight lines with the values of t and the corresponding total amount of beta-activity I of the individual hot particles. The values of index α represented the slopes of the characteristic decay curves shown as straight lines were calculated by the method of least squares, and the distributions of values of α were also obtained. The decay characteristics of beta activity of the hot particles due to the third, the fifth and the seventh Chinese nuclear test explosions were determined. (auth)

Atmosphere

Refer also to abstract 12711.

12688 (INIS-mf-1138) STATE AND FORMS OF OCCURRENCE OF RADIOISOTOPES IN GLOBAL FALLOUT. Pavlotskaya, F. I. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow). 1973. 36p. (In Russian). INIS.

Regardless of the geographical location, the subject radioisotope content of the insoluble fraction of fallout is in the order $^{90}Sr > ^{137}Cs > ^{95}Zr > ^{95}Nb > ^{144}Ce$. The distribution of a nuclide between the soluble and insoluble states is due not only to the amount present but also to the chemical state. In winter the SO_4^{2-}, Cl^-, Na^+, and K^+ ions and both the total dissolved and undissolved fraction increase. The chemical state of samples in rain, dry fallout, and mixtures differs. Data are presented which show that a large part of the nuclides is in exchangeable and mobile states. It is suggested that the fraction insoluble in water is in the form of simple carbonates and sulfates (^{90}Sr, ^{144}Ce); binary sulfates, carbonates, and nitrates (^{144}Ce, ^{137}Cs); oxides (^{144}Ce); and other compounds. Especially noted are the "hot" particles, in which form radioisotopes reach the earth's surface. The radiation state of three fractions collected in Osaka, Japan, and Fayetteville, USA in an explosion May 9, 1966, is discussed. In all particles the amounts of radioisotopes were in the order $^{147}Nd > ^{143}Pr > ^{144}Ce > ^{95}Zr > ^{99}Mo > ^{141}Ce > ^{91}Y > ^{140}Ba > ^{89}Sr > ^{103}Ru$. The solubility of "hot" particles in various chemical reagents was no more than 8% in 6N HCl and 2% in 6N NH_4OH. (tr-auth)

12689 (INIS-mf-1216, pp B16-29) MEASUREMENT OF THE CAPACITY OF URBAN AIR FOR POLLUTION USING NATURAL RADIOACTIVITY. Assaf, G. (Weizmann Inst. of Science, Rehovoth, Israel); Tzur, Y. 1973.

From fourth scientific conference of the Israel Ecological Society; Tel Aviv, Israel (8 Apr 1973).

When a wind from the sea reaches the shore it becomes enriched with radioactive gases emanating from the ground and with their radioactive decay products. Of the emanation products, ^{212}Pb and ^{212}Bi are of special interest. A series of measurements shows that the ^{212}Pb concentration varies between 0.04 and 2 pc/m^3, and the ^{212}Pb to ^{212}Bi activity ratio between 1 and 10. The measurements verify that there is a substantial local emanation of ^{220}Rn, which modifies the above quantities. A two-layer numerical diffusion model for their distribution is presented. It is concluded that these natural tracers can be employed to measure the mixing rates between the air in the street layer and the advective layer above, and the diffusivity in the advective layer. These parameters, together with the wind speed, determine the capacity of urban air for pollution. (INIS)

12690 (SCPRI(RM)-12-1973) REPORT OF ACTIVITY, DECEMBER 1973. (Service Central de Protection Contre les Rayonnements Ionisants, 78–Le Vesinet (France)). 1973. 16p. (In French). Dep. NTIS (US Sales Only) $4.00.

The principal results concerning the surveillance of radioactivity in the environment are presented: atmospheric dusts (air at ground level, high altitude air), rainwater, surface water, underground water, irrigation water, drinking water, food chain (milk, plants, cattle, fish), sea water around nuclear plant sites, and other sites. The activities of various radioisotopes are presented in tables (^7Be, ^{95}Zr and ^{95}Nb, ^{103}Ru, ^{131}I, ^{137}Cs, ^{140}Ba and ^{140}La, ^{89}Sr, ^{106}Ru and ^{106}Rh, ^{226}Ra, ^{54}Mn, U, and T). A monthly bibliographic selection is also presented. (FR)

12691 (SCPRI(RM)-12-1973(Suppl.)) ANNEX TO MONTHLY REPORT, DECEMBER 1973. Detail of Results of Measurement. (Service Central de Protection Contre les Rayonnements Ionisants, 78- Le Vesinet (France)). 1973. 27p. (In French). Dep. NTIS (US Sales Only) $4.50.

Measurement tables concerning the surveillance of the environment (see also the SCPRI-RM-12-1973 report) are presented. Radioactivity of atmospheric dusts, rain water, drinking water, food chains, and sea water around reactors was monitored. Data are presented for the following: ^{7}Be, ^{95}Zr, ^{95}Nb, ^{103}Ru, ^{131}I, ^{137}Cs, ^{140}Ba, ^{140}La, ^{90}Sr, ^{106}Ru, ^{106}Rb, ^{226}Ra, ^{54}Mn, U, and T. (FR)

12692 GAMMA RADIATION FROM RADON DAUGHTERS IN THE ATMOSPHERE. Beck, H.L. (Health and Safety Laboratory, U. S. Atomic Energy Commission New York, New York 10014). J. Geophys. Res. 79: No. 15, 2215-2224 (20 May 1974).

The gamma ray flux and ionization from the decay products of ^{222}Rn in the atmosphere and the corresponding photon energy and angular distributions as a function of height above the air–ground interface have been calculated for several vertical ^{214}Pb and ^{214}Bi concentration profiles. These physical properties are compared with the corresponding radiation field resulting from sources in the soil. It was found that for normal turbulence the radon daughter gamma flux at ground level is only about 2% of the typical soil source flux, whereas for an inversion this ratio is of the order of 20%. At 100 m, radon daughters account for about 5% of the total gamma flux for normal turbulence and about 25% under inversion conditions. At 100 m the radon daughter produced flux is harder than the flux from soil sources, and the skyshine of gammas greater than 500 keV is much larger than the skyline from soil sources. These results suggest means of separating out airborne radon contributions from total gamma flux or ionization measurements. Other applications of the calculated results to natural background radiation variations, natural fallout, and measurement interpretation are discussed. (auth)

12693 MEASUREMENT OF ATMOSPHERIC ^{85}Kr ACTIVITY AT DEBRECEN (HUNGARY). II. Csongor, E. (Inst. of Nuclear Research, Debrecen, Hungary). Acta Phys. Acad. Sci. Hung.; 34: No. 2-3, 249-253(1973).

The concentration of ^{85}Kr in air as measured with internal GM counters has increased steadily in the last years and amounts to 16.2 pCi/m^{3} of air in 1971. The total amount of fissioned material is estimated. (auth)

12694 ROOM AND EXHAUST AIR MONITORING FOR RADIOACTIVITY. Neumann, W. (Kernforschungszentrum, Karlsruhe, Ger.). Atomwirt., Atomtech.; 19: No. 4 206(Apr 1974). (In German).

A colloquium held at the Kernforschungszentrum Karlsruhe is reported in which 15 lectures review the state of the art in room and exhaust air radioactivity control. The lectures and discussions will be published as KFK-report No. 1899. (GE)

12695 MOST PROBABLE FORMS OF ^{90}Sr AND ^{137}Cs IN ATMOSPHERIC PRECIPITATES AND GLOBAL RADIOACTIVE FALLOUT. Zhilkina, M. I.; Gedeonov, L. I.; Gritchenko, Z. G. Flegontov, V. M. Sov. Radiochem. (Engl. Transl.); 15: No. 4, 578-584(1973).

Translated from Radiokhimiya; 15: No. 4, 576-584(1973).

It was shown that the liquid fraction of atmospheric precipitates and global radioactive fallout contains up to 90% of the total ^{90}Sr and 70% of the ^{137}Cs present in the sample; the main form is cationic. It is improbable that the ^{90}Sr and ^{137}Cs fallout is in compounds of alkali and the alkaline earth elements that are difficultly-soluble in water. It was established that the solid fraction of atmospheric precipitates and global radioactive fallout contain up to 10% of the ^{90}Sr and up to 30% of the ^{137}Cs. They are present in difficultly soluble refractory compounds, which are formed in the initial stage of the formation of radioactive aerosols by condensation of the gaseous products of a fireball. (auth)

Soil

12696 (INIS-mf-1136) LANDSCAPE-GEOCHEMICAL ASPECTS OF ^{90}Sr BEHAVIOR IN THE FOREST AND FLOOD-PLAIN ECOSYSTEMS OF WOODED BOGGY AREAS. Tyuryukanova, E. B.; Belyaeva, L. I.; Levkina, N. I.; Emel'yanov, V. V. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow). 1973. 40p. (In Russian). INIS.

In woods podzols and fallow forest sands from 1962 to 1964 the ^{90}Sr content increased and then began to drop. The ^{90}Sr distribution in forest soils was spotty and depended on the litter. It accumulated in coniferous litter with a high content of crude humus. Mosses had a higher ^{90}Sr content in the surface parts than did grasses. In herbaceous plants a significant amount of ^{90}Sr was contained in the root systems. Strontium-90 was unequally distributed in the designated soils. It was lost from slightly developed soils and accumulated in woods and meadow soils. (tr-auth)

Water

Refer also to abstract 12772.

12697 (NVO-1253-6) HYDROLOGY AND RADIONUCLIDE TRANSPORT MONITORING WELL HT-2m, TATUM DOME, MISSISSIPPI. Fenske, P. R. (Nevada Univ., Reno (USA). Desert Research Inst.). Dec 1973. Contract AT(29-2)-1253. 19p. Dep. NTIS $3.00.

The Salmon Event was detonated in October 1964 in the Tatum Salt Dome at a depth of 2700 ft. Between March and July of 1965, well HT-2 was used for the disposal of radioactive waste into the Cook Mountain Limestone. A hydrologic monitoring well, HT-2m, was drilled to monitor the aquifer into which the waste was injected. This well was later found to be flowing. No contaminated water has flowed out of the well. The water column presently contains tritium concentrations above background but below the Radiation Concentration Guide (RCG) for tritium in water. The concentration of tritium in HT-2m will reach RCG in about 20 years. Movement of the tritiated waste water was investigated. The conclusions are: (1) movement in aquifer 5, the Cook Mountain Limestone, is caused by injection of oil field brine at the Baxterville Oil Field and will not continue indefinitely since injection of brine will ultimately cease; (2) maximum movement of water containing an above background concentration of tritium in aquifer 5 will be about 1200 ft; (3) if a leak occurs between aquifer 5 and aquifer 4, maximum movement in aquifer 4 of water containing tritium in above background concentration will be about 340 ft; and (4) the movement of salt water through a leak connecting aquifer 5 to aquifer 4 will ultimately cause a greater degradation of aquifer 4 than the movement of tritiated water. It is recommended that HT-2m be plugged back and recompleted in aquifer 4 and/or new monitoring well for aquifer 4 be drilled near the southern boundary of the site. (auth)

12698 RADIOACTIVITY OF THE WATER OF THE NORTHEASTERN PART OF THE ATLANTIC OCEAN. Bakshe'eva, I. P.; Zemlyanoi, A. D.; Markelov, V. N.; Nelepo, B. A. (Marine Hydrophysical Inst., Sevastopol). Oceanology (USSR) (Engl. Transl.); 11: No. 6, 861-867(Aug 1972).

In addition to radioactive fission products from nuclear weapons tests, radioactive wastes of atomic industrial facilities discharged into the ocean are an important source of radioactive contamination of some regions of the world's oceans. Spatial distribution studies in the northeastern Atlantic indicated that the content of ^{90}Sr at the end of 1965 and the beginning of 1966 was higher than the average level for the ocean and amounted to about 53 counts/min-100 l in the surface layer. The most intense transport of artificial radioactive products out of the Irish Sea was detected in the northern and northeastern directions along the Hebrides and the Orkneys. (Pollut. Abstr.)

Ecosystems and Food Cycles

Refer also to abstract 13020.

12699 (INIS-mf-1132) ^{210}Pb, ^{210}Po, ^{226}Ra, ^{228}Th, AND ^{239}Pu IN THE LICHEN-DEER-MAN CHAIN IN THE USSR ARCTIC. Nizhnikov, A. I.; Ermolaeva-Makovskaya, A. P.; Ibatullin, M. S.; Lisachenko, E. P.; Litver, B. Ya.; Ramzaev, P. V.; Teplykh, L. A.; Troitskaya, M. N. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow). 1973. 10p. (In Russian). INIS.

Radioecological studies of the subject nuclides carried out from Chukotin to the Kol'ski Peninsula for a number of summers showed that long before the appearance of nuclear weapons the ^{210}Pb concentration in lichens and the bones of deer was about the same for 50–60 years. The multiplicity factors of ^{226}Ra, ^{239}Pu, ^{90}Sr, and ^{137}Cs accumulation were calculated to be a factor of 2 to 6 lower for deer than for man. The different situation for ^{210}Pb may be related to a different rate of exchange or of absorption in the gastrointestinal tract. (tr-auth)

12700 (INIS-mf-1135) GLOBAL ^{137}Cs AND ^{90}Sr MIGRATION IN FOOD CHAINS OF THE POPULATION OF UKRAINIAN WOODED BOGGY AREAS. Mukhin, I. E.; Moiseev, A. A.; Nagovitsina, L. I.; Chernysh, E. A. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow). 1973. 18p. (In Russian). INIS.

The densities of ^{137}Cs and ^{90}Sr fallout in the Northern Hemisphere are the same. A high rate of transfer of ^{137}Cs and a some-

what lower rate for ^{90}Sr to grass and agricultural products of plant origin was observed on sandy and loomy podzols. The lightness of soils determines the rate of ^{137}Cs and ^{90}Sr penetration of the soil profile. Some 10–15% of both nuclides is found in a layer of 30–40 cm. The highest concentrations in food products, observed over several years, was in meat, milk, and mushrooms. The chief ^{137}Cs in the daily food of the people observed was in the order meat, bread, and vegetables. The ^{90}Sr accumulation in bone tissue of children was 1.3 to 1.4 times that in other parts of the Ukraine. (tr-auth)

12701 (NIRS-C-1) SURVEY ON FOOD CONSUMPTION FOR INHABITANTS AROUND NUCLEAR SITES IN COASTAL AREA OF IBARAKI PREFECTURE. Ohmomo, Y. (comp.). (National Inst. of Radiological Sciences, Chiba (Japan)). Mar 1974. 222p. Dep. NTIS (US Sales Only) $14.25.

Not only radioactive nuclides but also pollutants released into environment enter into human bodies through foods. In order to take countermeasures for protection before the fact, it is necessary to explain the route of radioactive nuclides or pollutants from their origin to human beings and consequently to establish the method for the estimation of the amount of those hazardous substances ingested by human beings. It is recognized that the uptake rate by critical organs are sometimes affected by coexisting isotopes and substances chemically similar to them, especially in the case of radioactive nuclides. Radioactive contamination and environmental pollution are ultimately nation-wide problems, but inhabitants around nuclear power sites should be considered the urgent group for study. It is believed that the food consumption rate of inhabitants is one of the most important and basic factors used for the estimation of those substances ingested. Along the coastal section of Ibaraki Prefecture, Japan, there are several kinds of nuclear establishments such as Japan Atomic Energy Research Institute (JAERI), Power Reactor, and Nuclear Fuel Development Corporation (PNC), and the Japan Atomic Power Company. In the site of PNC in Tokai, a nuclear fuel reprocessing plant has been constructed, and the second big nuclear power reactor is under construction there and in Oharai, the operation of a prototype fast breeder reactor is expected. In Japan, nuclear establishments are mostly situated in coastal areas and therefore in case of discharge of radioactive nuclides into the sea, fishermen are the critical population. In case of the release of radioactive effluents into atmosphere, farmers might be the critical population. (auth)

12702 ROLE OF SOIL ANIMALS IN THE BIOGENIC MIGRATION OF Ca AND ^{90}Sr. Krivolutskii, D. A.; Pokarzhevskii, A. D. (Inst. of Evolutionary Morphology and Ecology of Animals, Moscow). Zh. Obshch. Biol.; 35: No. 2, 263-269(1974). (In Russian).

The quantitative distribution of Ca and ^{90}Sr in the experimentally contaminated ecosystem under investigation is as follows: 234 g per m^2 of Ca and 200 μCi of ^{90}Sr are recorded in the soil. The respective values for the vegetation are 50 g per m^2 and 500 μCi, for leaffall and litter—10 g per m^2 and 430 μCi respectively. In animals 47 mg per m^2 of Ca and $24.5 \cdot 10^{-3}$ μCi per m^2 of ^{90}Sr are found, the invertebrates contributing 42 mg per m^2 and $20 \cdot 10^{-3}$ μCi per m^2 respectively. Earthworms' rank is the highest among invertebrates with respect to Ca accumulation (8.8 mg per m^2), that of insects with respect to ^{90}Sr accumulation (1.10^{-2} μCi per m^2). Among vertebrates the highest respective values (3 mg per m^2 and $30 \cdot 10^{-4}$ μCi per m^2) are recorded in rodents. The amount of ^{90}Sr accumulated by animals and passing annually through the food chains constitutes only 0.6% of the annual decomposition of the radionuclide in question in the ecosystem. As ^{90}Sr which goes into the ecosystem is absorbed by the soils and is involved in the biological turnover, the index of the biogenic migration of the given radionuclide by the animals is comparable to that of its distribution by air and to the amount of ^{90}Sr washed off the ecosystem by the rain water. (auth)

12703 REVIEW OF TRANSURANIC ELEMENTS IN SOILS, PLANTS, AND ANIMALS. Price, K. R. (Battelle Pacific Northwest Labs., Richland, WA). Aerosp. Med.; 2: No. 1, 62-66(1973).

Published information concerning the distribution and fate of Np, Pu, Am, and Cm in terrestrial ecosystems is reviewed and areas needing further study are identified. The transuranic elements do not remain in soils, plants, or animals, but organic complexes and chelations greatly enhance mobility as does oxidation state. Ingestion is the most important transfer mechanism in ecosystems but assimilation from natural food sources is mostly unknown. The literature suggests three possible uptake mechanisms in plants: the formation of organic complexes or chelates, root surface concentration, or slow but continual uptake by perennials. (Pollut. Abstr.)

12704 CONCENTRATION OF IODINE IN MILK FROM DIFFERENT LOCATIONS IN NORWAY DURING THE 12-MONTH PERIOD JULY 1971—JUNE 1972. Rensa, T.; Staveland, K. Tidsskr. Norske Laegforen.; 94: No. 15, 990-993(30 May 1974). (In Norwegian).

The iodine concentration in milk samples from one farm and eleven dairies in Norway has been determined by neutron activation analysis. The milk examined contained high amounts of iodine compared to results from similar investigations in other countries. Winter values are higher than summer values. The average concentration in the summer was 6.6 μg I/100 ml, in the winter 12.7 μg I/100 ml. No differences could be detected between coastal and inland areas or between areas situated in the northern and southern parts of the country. Possible explanations for the high values are discussed. Attention is drawn to the relatively extensive use of seaweed meal for dairy cows in the winter season. (auth)

Radiometric Techniques

Refer also to abstract 12735.

12705 (INIS-mf-1214, pp D68-70) STUDIES OF ENVIRONMENTAL SYSTEMS BY TRACER METHODOLOGY. Gat, J. R.; Nir, A. (Weizmann Inst. of Science, Rehovoth, Israel). 1973.

From fourth scientific conference of the Israel Ecological Society; Tel Aviv, Israel (8 Apr 1973).

Recent developments in the methodology of stable isotope tracers (Deuterium, ^{18}O, ^{13}C, ^{15}N), together with the known applications of tritium and ^{14}C, have opened up new possibilities in studies on the quality of the environment. In addition to describing the dynamic behavior of environmental systems, the combined tracing and dating approach facilitates reconstruction of the geochemical history of critical pollution areas and enables the testing of models describing complex environment systems and their response to changes, natural or man-made. Surveys of the tracer variation in the systems provide a base line for distinguishing between natural and man-made changes; the models calibrated on the past evolution of the system can then be used to forecast the effect of possible future environmental changes. The discussion includes the pollution effects caused by direct introduction of noxious substances as well as by increases in the concentration of natural constituents as a result of man-induced changes in the water balance and flow regime. (auth)

12706 CALIBRATION OF THE RADIOCARBON TIME SCALE. Baxter, M. S. (Univ. of Glasgow); Clark, R. M.; Renfrew, C.; Aitken, M. J. Nature (London); 249: No. 5452, 93-94(3 May 1974).

Reference is made to Clark and Renfrew (Nature 243: 266(1973)) and a series of other papers on this subject, in which attempts are made to smooth out irregularities in data curves. The present author questions such practices, and considers that the methods employed are not justified by the quality of the ^{14}C results nor by present understanding of ^{14}C geochemistry. In order to assess the real accuracy of tree measurements an answer is required to the following questions: is the ^{14}C level of wood grown at altitudes indicative of concentrations at sea level, and is there a latitude effect?; is the ^{14}C content of wood fractions other than the cellulose component necessarily a precise measure of atmospheric ^{14}C levels during the wood growth?; can experimental unknowns, such as counter behaviour, contamination effects, human error, standardization, and half-life uncertainty be entirely neglected; and are systematic differences between ^{14}C laboratories possible? Comments are offered on these questions. It is considered that it would be unwise to attribute an absolute accuracy of better than ±2% to calibration curves; a 1% error in ^{14}C content corresponds to a radiocarbon age error of 80 yr. The curves should be imagined not as lines, but as probability bands of considerable spread (400 yr), and kinds may well exist. Some comments are also offered by M. J. Aitken of the Research Laboratory for Archeology, Oxford, and a reply by Clark and Renfrew is appended. (UK)

12707 STUDYING THE CLAYS OF ALEURITE-SANDY ROCKS FROM THE GAMMA-LOGGING RESULTS. Sharabarin, V. D.; Sokolov, M. S. Izv. Vyssh. Ucheb. Zaved., Neft Gaz; No. 1, 9-12 (1973). (In Russian).

The results of gamma logging were compared with those of weight, volume, and relative-clay-content methods for the lower Cretaceous deposits of the Vostochno-Bezvodnyi deposits of the Sta'ropolskii Region. Under the conditions of these deposits there is a firm correlation between the clay content of the silt-sandstone and the natural gamma radiation emission rate. From the results it was possible to distinguish the collecting layers in a borehole section, to estimate the clay content quantitatively, and to study the nature of their distribution in the deposits. (tr-auth)

12708 DETERMINATION OF THE QUALITATIVE PARAMETERS OF COMBUSTIBLE SHALES FROM THE GAMMA-

GAMMA WELL-LOGGING DATA. Miroshnichenko, V. M. Razved. Geofiz.; No. 56, 170-175(1973). (In Russian).

The possibility is examined of determining the qualitative nature of combustible shales (heat capacity, organics content, tar yield) from gamma-gamma logging data. The precision of the determination is directly proportional to the intensity of the dispersed gamma radiation and is higher than with intermediate determination of the density. (tr-auth)

12709 ADVANTAGES OF THE USE OF RADIOACTIVE TRACERS ^{222}Rn AND ^{212}Pb FOR THE STUDY OF AITKEN NUCLEI WITHIN THE LOWER TROPOSPHERE. Lopez, A.; Guedalia, D.; Servant, J.; Fontan, J. (Physique des Aerosols et Echanges Atmospheriques, Centre de Physique Atomique, Université Paul Sabatier, Toulouse, France). J. Geophys. Res. 79: No. 9, 1243-1252 (20 Mar 1974).

The vertical profiles of Aitken nuclei within the atmosphere (0-3000 m) are compared with those of the natural radioactive tracers radon and ^{212}Pb originating from continental areas. The latter tracers enable both the intensities of the vertical exchanges to be measured and the often difficult meteorological analysis to be undertaken. Under certain experimental conditions this comparison enables the source of nuclei within the atmosphere to be located in space and the apparent half-life for the disappearance of these particles to be determined. From the preliminary results obtained concerning the Aitken nuclei this study demonstrates the advantages of the use of radioactive tracers in research concerning the evolution of the trace constituents within the troposphere. (auth)

Site Surveys

Refer also to abstract 12715.

12710 (ANL/ES-40(Vol. 15)) ENVIRONMENTAL STATUS OF THE LAKE MICHIGAN REGION. Volume 15. Mammals of the Lake Michigan Drainage Basin. Long, C. A. (Argonne National Lab., Ill. (USA)). May 1974. Contract W-31-109-eng-38. 108p. Dep. NTIS $5.45.

A catalog is presented of the wild mammals that inhabit the land in the drainage basin of Lake Michigan. (auth)

12711 (KFK-1934) ON-LINE DATA ACQUISITION AND DATA PROCESSING IN A METEOROLOGICAL TOWER-PDP-8/I-CALAS SYSTEM COUPLING. Suess, F.; Thomas, P. (Kernforschungszentrum Karlsruhe (F. R. Germany)). Feb 1974. 29p. (In German). Dep. NTIS (US Sales Only) $4.50.

The hardware and software configuration for acquisition and processing of meteorological data measured at the Karlsruhe Nuclear Research Center is described. A PDP-8/I installed near the place of measurement reduces the data collected which are transferred to a TR 86 and subsequently stored on magnetic tape and disc. Both computers are coupled through the CALAS 69/4 operating system offering to the user on-line data acquisition and real-time data evaluation through multiprocessing and time sharing. (auth)

12712 (UCRL-51592) GEOLOGICAL AND SEISMOLOGICAL INVESTIGATION OF THE LAWRENCE LIVERMORE LABORATORY SITE. Wight, L. H. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 17 May 1974. 90p. Dep. NTIS $7.50.

In response to an AEC request for Safety Analysis Reports for all critical structures on the Lawrence Livermore Laboratory site, the seismic hazard at LLL were examined. The geology and seismology of the Livermore Valley and surrounding regions were reviewed, and all the active faults in the region based on seismic history, geomorphology and geodetic data were identified. After carefully estimating the accelerations that the site would experience from maximum magnitude earthquakes on each active fault, it was concluded that the Tesla fault has the most potential for doing damage at the LLL site. The response spectrum is derived. (auth)

12713 LOCAL WELFARE TYPE POWER GENERATION SITING SYSTEM. Ito, A. (Nippon Kogyo Ricchi Senta, Japan). pp 373-407 of Siting and Environmental Problems in the Development of Electric Power Stations. Its Status and Analysis. Tomioka, K. (ed.). Tokyo; Fuji International Co. (1973). (In Japanese).

In discussing energy supply and industrial activities in 1970s in Japan, environmental conservation must be taken into full consideration. Human beings and their natural surrounding must be in a balanced ecological system. In conceiving the power generation scheme of local welfare type, total energy system and closed ecological system must be referred to appropriately. After explaining these two viewpoints, examples of thermal power stations of local welfare type in Japan are given. Similarly, nuclear power generation and desalination are reviewed, with regard to the desalination requirements for Japan, its practicable means, etc. (JA)

Thermal Effluents

Refer also to abstracts 14535 and 14606.

12714 (KFK-1966-UF) ENERGY AND THE ENVIRONMENT IN BADEN-WUERTTEMBERG. Faude, D.; Bayer, A.; Halbritter, G.; Spannagel, G.; Stehfest, H.; Wintzer, D. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Angewandte Systemtechnik und Reaktorphysik). Apr 1974. 183p. (In German). Dep. NTIS (US Sales Only) $12.25.

The environmental impacts of energy production and consumption are investigated. Special emphasis is placed upon the energy conversion sector, i.e., power stations and refineries and upon the regional problems of the Upper Rhein area. Thermal and chemical emissions, and their regional distribution, are determined from a regional analysis of the energy statistics of Baden-Württemberg. The problem of the effects of environmental pollution is addressed by two examples: effects of ionizing radiation and epidemiological analyses of air pollution (SO_2). For the regional area of the Upper Rhein the following problems are investigated in greater detail: thermal capacity of the Rhein River under various meteorological conditions; effects of wet cooling towers with natural draft; expected radiation doses from nuclear facilities; and air pollution, i.e., a map of the regional SO_2-concentrations calculated from data on emissions and meteorological conditions. (auth)

12715 (TID-26605) ECOLOGICAL STUDY OF SOUTH BISCAYNE BAY AND CARD SOUND, THE THALASSIA MICROCOSM. Annual Report. Thorhaug, A. (Miami Univ., Coral Gables, Fla. (USA)). Jun 1974. Contract AT(40-1)-4493. 246p. Dep. NTIS $15.50.

Results are reported on research studies during 1973 and 1974 on the distribution, abundance, growth, productivity, and reproductive patterns of the seagrasses and macroalgal communities in Card Sound and Turkey Point, Florida. Conclusions from past years are also presented in summary form. This study is a part of a larger study of this area which included chemical and physical oceanography as well as biological aspects, and was coordinated with the other investigations. The primary change that occurred in the study area during 1973 and 1974 was the completion of the self circulating cooling canal system at the Turkey Point nuclear power facility. The result was that no effluent was discharged into Card Sound as was done on an intermittent basis during 1971 and 1972. The regrowth of seagrasses and algal communities at Turkey Point was monitored at seven stations during 1973 and 1974. (auth)

12716 THREE-DIMENSIONAL HEATED SURFACE JETS. Stolzenbach, K. D.; Harleman, D. R. F. (Massachusetts Inst. of Tech., Cambridge). Water Resour. Res.; 9: No. 1, 129-137 (Feb 1973).

A theory for the 3-dimensional temperature and velocity distribution in a heated water discharge issuing from a rectangular channel at the water surface is developed by considering the effects of lateral gravitational spreading, reduction of vertical entrainment, and surface heat loss on a free turbulent jet. The behavior of such a heated jet depends primarily on the initial densimetric Froude number and to a lesser extent on the depth-width ratio of the discharge channel. The gravitational stability of the jet and the angle of lateral spread increase away from the discharge point, whereas the vertical entrainment decreases. Heat loss through the water surface is significant only far from the discharge point, where the jet is plumelike rather than jet-like. The theoretical results are verified by experimental evidence. (Pollut. Abstr.)

12717 DYNAMIC SURFACE TEMPERATURE STRUCTURE OF THERMAL PLUMES. Scarpace, F. L.; Green, T. III. (Univ. of Wisconsin, Madison). Water Resour. Res.; 9: No. 1, 138-153 (Feb 1973).

Airborne thermal imagery is used to show that thermal plumes often vary rapidly in space and time, although both the initial thermal effluent and the receiving water change very little. The imagery is buttressed by simultaneous data taken from boats. The rapid variations can cast doubt on the validity of some standard methods of measuring thermal plumes. The plume is sometimes dominated by a series of concentric thermal fronts that spread radially outward from the outfall. Various tentative explanations for their occurrence are given. (Pollut. Abstr.)

12718 EFFECTS OF WARM DRAIN WATER ON THE ENVIRONMENT AND ITS UTILIZATION. Motoda, Y. (Nuclear Safety Research Association, Tokyo). pp 234-252 of Siting and Environmental Problems in the Development of Electric Power Stations. Its Status and Analysis. Tomioka, K. (ed.). Tokyo; Fuji International Co. (1973). (In Japanese).

Warm waste water released from power stations has considerable significance environmentally because of the large quantity involved. On the other hand, the heat of thermal effluents can be used in many ways. The effects of warm water on the environment, such as on aquatic life, sea state, weather, etc., are outlined, and the various phases of utilization of warm water are discussed. The utilization of the warm waste water from thermal and nuclear power stations can be divided broadly in two categories, i.e., physical and biological uses. Among the former uses are industrial process heating, ice and snow melting, and so on. The latter uses include those in fisheries and those in agriculture such as for greenhouse heating and warm water irrigation. Finally, the techniques of usage both in fisheries and agriculture are reviewed. (JA)

12719 APPROXIMATION OF HEAT EXCHANGE AT THE AIR-WATER INTERFACE. Jackman, A. P.; Faust, C. R. Water Resour. Res.; 9: No. 1, 118-128(Feb 1973).

The basic exchange equations for air-water interface are approximated by the Taylor series expansion around an undefined base temperature in order to calculate short-term heat exchanges. The expression short-term is used to indicate averaging over a period on the order of 1 hr. Numerical tests based on data from 2 shallow streams verify that the base temperature should be chosen so as to minimize deviations between the base temperature and the actual water temperature. The daily average natural temperature observed at a reference point is the most practicable base. The daily equilibrium temperature calculated from meteorologic data may be used as a base as long as it does not deviate excessively from actual water temperatures. Whereas the short-term natural temperature is the most accurate base, the short-term equilibrium temperature has no merit as a base temperature of linearization. (Pollut. Abstr.)

12720 SIMPLIFIED MATHEMATICAL MODEL OF TEMPERATURE CHANGES IN RIVERS. Novotny, V.; Krenkel, P. A. (Associated Water and Air Resources Engineers, Inc., Nashville). J. Water Pollut. Contr. Fed.; 45: No. 2, 240-248(Feb 1973).

A mathematical model of river temperature computations based on the general equations of turbulent heat transfer was developed and laboratory and field tested. The model takes into account the dynamic character of the air-water interface where both boundaries are moving and turbulent. For a known natural water temperature, the determination and the dissipation of an imposed heat load is significantly simplified, inasmuch as measurements of cloud cover, solar radiation, and humidity are not necessary. The overall heat exchange coefficient depends only on the wind velocity, the stream surface velocity, the air temperature, and the size of the water surface. (Pollut. Abstr.)

12721 ANALYSIS OF ENGINEERING ALTERNATIVES FOR ENVIRONMENTAL PROTECTION FROM THERMAL DISCHARGES. Crutchfield, J. A.; Welch, E. B.; Bell, M. C.; Geitner, N. M.; Bush, R. M.; Meyer, T.; Porter, R.; Saad, A. H. (eds.). Environmental Protection Technology Series EPA-R2-73-161. Washington, DC; Environmental Protection Agency (1973). 235p.

An analytical framework to evaluate current and proposed engineering practices used in the protection of the environment (both freshwater and marine) from the impact of thermal power systems is described. The engineering practices modeled included the heat source/generating system, the electrical power transmission system, the water intake system, the cooling system, and the chemical control of the water systems. An ecological accounting system was developed to provide a nonmonetary measure of biological response to the engineering alternatives. Efforts to formulate a socioeconomic accounting system to internalize externalities created by these engineering practices were unsuccessful. A computer model was developed employing a decision tree format to evaluate the environmental and economic impacts of these engineering alternatives for any given site. Methodologies available to assess the impact of a series of power plant developments in a region were evaluated and the Forrester type (1971) feedback simulation for a few variables was best suited for dynamic assessment problems. Both static and dynamic analytical frameworks have been verified to be computationally correct, but an extensive demonstration program is required to prove their applicability. (Pollut. Abstr.)

Chemical Effluents

Refer also to abstracts 12705 and 12714.

INSTRUMENTATION

Radiation Detection Instruments

General Detectors and Monitors

Refer also to abstracts 12251, 12252, 13316, 13321, 13504, and 13714.

12722 (AD-732789) CALIBRATION OF THE CONCORDE RADIATION DETECTION INSTRUMENT AND MEASUREMENTS AT SST ALTITUDE. Friedberg, W.; Nelson, J. M. (Federal Aviation Administration, Oklahoma City, Okla. (USA). Civil Aeromedical Inst.). Jun 1971. 20p. NTIS.

Performance tests were carried out on a solar cosmic radiation detection instrument developed for the Concorde SST. The instrument calibration curve (log dose-rate vs instrument reading) was reasonably linear from 0.004 to 1 rem/hr for both gamma radiation and fast neutrons. Nonlinearity in the calibration curve was observed at dose rates below 0.003 rem/hr. The instrument responded normally after exposure to 30 rem/hr of gamma radiation. The charged particle detectors showed a directional response apparently because of the neutron moderator. The neutron detector did not show a directional response. Measurements made with the Concorde instrument at 60,000 ft. and high geomagnetic latitudes indicated a galactic cosmic radiation dose rate of 0.7–0.9 millirem/hr. (auth)

12723 (EUR-5122(Vol.1), pp 189-220) STUDY OF ALPHA TRACK PATTERNS BY MEANS OF THE ACTIVATED DEVELOPMENT PROCEDURE FOR IONOGRAPHIC EMULSIONS. Wittendorp, E.; Horrenberger, A.; Aiguabella, R.; Rechenmann, R. V. (Univ. Louis Pasteur, Strasbourg). Mar 1974.

From fourth symposium on microdosimetry; Verbania, Italy (24 Sep 1973).

An experimental study on the structure of low energy α particle ($E \leq 11$ MeV) tracks recorded in fine grain nuclear emulsions has been undertaken. The theory of the stable ionographic sublatent image and its "activation" is recalled and the results of some "activated" development procedures shortly described. A visual detector of a high recording efficiency combined with a minimum fog level can thus be applied to the analysis of charged particle track structure. Along α tracks recorded in emulsions which have been submitted to an activated treatment, secondary track events of various morphologies can be observed at light and electron microscopic level. All the experimental results led to the conclusion that most of the observed events cannot be considered as artifacts. It is supposed that the protuberances may be at least partly due to δ rays and to recoil proton tracks. A differential counting of events with radial spreads $r \leq 0.5$ μm and $r > 0.5$ μm along α tracks recorded in an Ilford L4 emulsion has been carried out. The number of events of the first class show a strong increase with the energy of the α particles, while the protuberances of the second class become more numerous with slowing down of the incoming particles. The trend of the corresponding histograms, when compared with the calculated yields of ejected δ rays and recoil protons in emulsions, seems to confirm that most of the studied secondaries are short tracks of electrons and probably of protons ejected by the incoming particle. (auth)

12724 (EUR-5122(Vol.1), pp 221-234) PRELIMINARY THEORETICAL ANALYSIS OF SECONDARY PRODUCTS ALONG ALPHA PARTICLE TRACKS RECORDED IN IONOGRAPHIC EMULSIONS. Aiguabella, R.; Ndocko Ndongue, V. B.; Rechenmann, R. V. (Univ. Louis Pasteur, Strasbourg). Mar 1974.

From fourth symposium on microdosimetry; Verbania, Italy (24 Sep 1973).

Standard emulsion is considered as a H, C, N, O, Br, Ag compound in which the dried biological tissue (gelatin) is loaded with AgBr microcrystals. Two main working hypotheses have been considered for identifying secondary events distributed along α particle tracks in hydrogeneous media: a) ionization of H, C, N, O and Br, Ag atoms leading to the ejection of energetic δ rays and b) elastic scattering of the lightest component, e.g. the hydrogen atoms. After convenient corrections, the comparison between the calculated and measured yields of δ rays and H-recoils shows a fairly good agreement. (auth)

12725 (JINR-13-6879) REASONS FOR THE CHANGE IN PROPERTIES OF PLASTIC SCINTILLATORS UNDER THE EFFECT OF DIFFERENT FACTORS. Shafranov, M. D.; Zhil'tsova, L. Ya.; Matveeva, E. N.; Klimova, A. Yu.; Golutvina, I. G. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1973. 6p. (In Russian). INIS.

Results are given on a study of the change in light yield of plastic scintillators under the effect of various factors acting on the polymer base of the scintillator. (SJR)

12726 (JINR-13-6894) ELECTRONIC CIRCUIT OF A MULTICHANNEL PROPORTIONAL COUNTER FOR MEASURING VERY LOW TRITIUM CONCENTRATIONS. Yanik, R.; Khudy, M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1973. 7p (In Russian). INIS.

This study describes the electronic circuit of a multichannel gas proportional counter for measuring very low tritium activities. By means of the circuit it is possible to register the counts of pulses in separate channels and to investigate the logical relations between channels. The circuit was developed in the Laboratory of Nuclear Problems OIYaI. (SJR)

12727 (KFKI-74-19) SETTING UP AND APPLICATIONS OF THE NUCLEAR MEASURING EQUIPMENT "DETECTOR SIGNAL PROCESSOR". Baranyai, A. (Kozponti Fizikai Kutato Intezet, Budapest (Hungary)). 1974. 19p. Dep. NTIS (US Sales Only) $4.00.

An item of equipment versatile in the field of nuclear pulse detector signal processes is dealt with. Initially the setting up of the equipment is shown in order to clarify its use. This is followed by a number of characteristic applications including several neutron counting systems using BF_3 and ^3He proportional counters and a charged particle spectroscopy system using a Ge(Li) semiconductor detector. The equipment has been designed for nuclear measurement applications where the decisive parameters (pulse shaping mode, time constant; detector bias resistor, etc.) largely dependent on the applied detector, are constant for a lengthy period. In such cases the low cost and the simple structure of the Detector Signal Processor demonstrate certain advantages in the field of nuclear measurements. (auth)

12728 RADIOACTIVITY AND RADIATION DETECTION. Miller, D. G. New York; Gordon and Breach, Science Publishers, Inc. (1972). 119p. $10.50.

The purpose of the text is to provide a summary of the practical and theoretical information that is necessary to an understanding of radioactivity and the intelligent application of radiation detectors. Emphasis is placed on the recognition of the applications and limitations of radiation detectors in the radiochemical laboratory and the nuclear technologies; and each of the many topics discussed is presented in summary form in order that the reader may quickly become familiar with the vocabulary and basic concepts of the subject. Designed primarily as a text for undergraduates, this book will also be of use to short-course students studying radioactivity and detection systems and, as a source of reference, to workers in many areas of radioactivity who are seeking quick definitions of terms and basic concepts. (auth)

12729 FAST NEUTRON FLUX MEASUREMENT USING GAS-FLOW TECHNIQUES. Brown, D. P.; Spear, W. G. (Westinghouse Hanford Co., Richland, WA). Nucl. Technol.; 23: No. 1, 87-93(Jul 1974).

A detector using a gas-flow technique to measure the in-core fast neutron flux was designed, developed, and experimentally tested. Based on the $^9Be(n,\alpha)^6He$ reaction of neutrons with beryllium, the method uses a flowing gas (helium) to bring the ^6He beta emitter to an ex-vessel beta detector to achieve measurements independent of the gamma irradiation of the in-vessel neutron detector. In tests at the TRIGA reactor of Washington State University, the system demonstrated a fast neutron sensitivity of 3.7×10^{-10} counts/sec per n/(cm^2 sec). Thus, using appropriate counting techniques, the technique could have an operational range of 10^9 to 10^{13} n/(cm^2 sec). (auth)

12730 COMPARISON OF GAMMA IRRADIATION PERFORMANCE OF THREE NEUTRON FISSION COUNTERS. Phillips, L. D.; Muhlestein, L. D.; Wood, M. R. (Westinghouse Hanford Co., Richland, WA). Nucl. Technol.; 23: No. 1, 80-86(Jul 1974).

A theoretical analysis concerning fission counter design and operation shows that an optimum ratio of cable impedance times detector capacitance over detector collection time exists for fission counters. Tests were performed to show the effects of gamma fields on fission chambers having different electrode spacings and various argon-nitrogen fill gas mixtures and pressures. Based on these tests, the FFTF in-vessel fission counters will have 0.080-in. plate spacing and be filled with 1.75 atm of Ar–7% N_2. The electrode coating thickness will be 2 mg/cm^2 of U_3O_8 (93% ^{235}U enriched). (auth)

12731 CRITERIA FOR THE EVALUATION OF THE DETECTION LIMITS OF MEASUREMENT DEVICES IN THE DETERMINATION OF LOW ACTIVITIES. Boehm, K.; Schuricht, V. (Technische Univ., Dresden). Kernenergie; 17: No. 1, 1-3(Jan 1974). (In German).

A quality factor for the characterization of measurement devices for highly sensitive activity determinations is derived, and detection limits of some measurement devices are determined from this factor. The quality factor G represents the reciprocal value of the detection limits under the assumption $\epsilon_p'/u_s' \times \sqrt{T} = 1\ min^{\frac{1}{2}}$. Quality factors for all measurement devices are compared with respect to their detection limits. (tr-auth)

12732 DC–DC CONVERTER FOR RADIATION MONITORS. Damljanovic, D. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). Isotopenpraxis; 10: No. 1, 28-30(Jan 1974).

A dc–dc converter for a portable G–M monitor is described. The converter can work at battery voltages from 2 to 6 V. (WHK)

12733 METHOD AND APPARATUS FOR MEASURING RADIOISOTOPE DISTRIBUTION. Petit-Clerc, Y. (to Universite De Sherbrooke). US Patent 3,808,440. 30 Apr 1974. Priority date 29 Oct 1971, United Kingdom of Great Britain and Northern Ireland. 8p.

A tomographic detector for studying and measuring radioisotope distributions in the human body consists of detectors, used preferably with positron emitters, connected to coincidence circuits in such a way as to determine two channels of detection wherein one channel is slightly offset with reference to an axis of rotation about which the object of interest is rotated while the other channel includes the axis. The method of measuring the local activity consists of first calculating the response of both channels and to subtract the counts of one channel from the counts of the other channel. This method provides a sensitive detection of a given volume with a sharp cut-off and a very weak response in the surrounding region, thus providing equal lateral and depth resolution. The present technique is valuable for medical section scanning and slow dynamic studies requiring the measurement of local activity. (Official Gazette)

12734 METHOD AND APPARATUS FOR SENSING RADIATION AND PROVIDING ELECTRICAL READOUT. Eichelberger, C. W.; Burke, H. K. (to General Electric Co.). US Patent 3,801,820. 2 Apr 1974. Filed date 9 Feb 1973. 14p.

A plurality of radiation sensing and storage sites are provided on a substrate of semiconductor material arranged in a plurality of rows and columns. Each site includes a row oriented plate and a column oriented plate to form a pair of closely coupled capacitive cells with the substrate. A plurality of row conductor lines are provided, each connected to the row oriented plates of a respective row. A plurality of column conductor lines are also provided, each connected to the column oriented plates of a respective column. Means are provided for selectively isolating the conductor lines from the substrate. During read out of charge stored in a particular site a selected row line and a selected column line are connected in circuit with the substrate. Accordingly, the charge injected into the substrate by such action is integrated across the inherent capacitance associated with the preselected row line instead of the inherent capacitance of all of the conductor lines with respect to the substrate. (Official Gazette)

12735 STATISTIC ANALYSIS OF THE RELATION BETWEEN THE READINGS OF THE RADIOACTIVE WELL-LOGGING INSTRUMENTS REGISTERED BY THE INDICATORS OF SEVERAL GAS-DISCHARGE COUNTERS AND THE ACTUAL GAMMA-RADIATION INTENSITY. Spasov, V. Prikl. Geofiz.; No. 70, 206-212(1973). (In Russian).

An analytical calculation was made of the loss of pulses in parallel-connected gas-discharge counters used in radioactive well-logging instruments during study of the geological cross section of deep wells with temperatures up to 200°C. The analytical dependences obtained offer the possibility of evaluating the artificial or natural γ activity of the rocks from the registered intensity of the γ radiation and the resolving time of the measurement system. The calibration method, based on the use of these dependences, makes it possible to obtain a more precise calibration of the well-logging instrument with gas-discharge counters and a more acceptable instrument from the safe viewpoint than existing methods of calibration. (tr-auth)

12736 DETECTION SCINTILLATION UNIT FOR RADIOMETRIC MEASUREMENT OF MINE CARS IN MOTION. Adamec, V. Czech Patent 146,218. 15 Nov 1972. 2p. (In Czech).

A scintillation detection unit is proposed for the radiometric measurement of mine cars in motion. It consists of a lead shielding cabinet into which cases are inserted of scintillation probes, of two lead collimating partitions, of an aluminum plate housing, and of a support. The scintillation probes are covered with lead and copper filters and are connected by cables to a measuring radiometric apparatus. The shielding cabinet and the collimating partitions are arranged so that the unshielded area in front of the scintillation probe forms a collimation angle ranging from 50 to 100°. (INIS)

12737 RADIONUCLIDE DEVICE WITH AUTOMATIC COMPENSATION OF RADIONUCLIDE DECAY. Seda, J.; Musilek, L. Czech Patent 146,449. 15 Dec 1972. 2p. (In Czech).

The device described consists of a single detector whose output is interconnected to the analyzer input. In the analyzer, the differential energy spectrum is separated into two signals by means of discrimination levels. The first signal carries information on the quantity measured and the second is independent of the quantity measured. The two analyzer outputs are connected to the inputs of a dividing circuit. The resulting ratio of the two signals is independent of a decrease in the radionuclide activity. The dividing circuit output is connected to the input of the terminal circuit in which the signal is indicated, recorded or otherwise evaluated. (INIS)

12738 INVESTIGATION OF RADIATION DURABILITY OF SURFACE-BARRIER dE/dx DETECTORS FOR IRRADIATION BY MULTIPLY CHARGED IONS. Kaganskaya, M. E.; Kolodin, A. V.; Sychkov, M. A. Instrum. Exp. Tech. (USSR) (Engl. Transl.); 16: No. 6, 1674-1675(1973).

Translated from Prib. Tekh. Eksp.; 16: No. 6, 55-56(1973).

The variation of the properties of silicon surface-barrier dE/dx detectors was investigated for irradiation by multiply charged ions. It was established that due to the action of irradiation the back current and pulse amplitude decrease and the energy resolution for absorption deteriorates. A partial recovery of the detectors was noted when they were held after irradiation. (auth)

12739 RECORDING OF NUCLEAR RADIATIONS BY RECTIFIER PHOTOCELLS. Avdonkin, S. I.; Sidorenko, A. V.; Sidorenko, V. V.; Soroka, V. V. (Leningrad Inst. of Aviation Instrument Design). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 16: No. 6, 1676-1680 (1973).

Translated from Prib. Tekh. Eksp.; 16: No. 6, 57-60(1973).

Results are presented of an experimental investigation of rectifier photocells and photocells with phosphors for the recording of fluxes of γ rays. Rectifier photocells allow the detection of nuclear radiation by autonomous dosimetric devices that do not draw electrical energy. The output current of the devices is proportional to the power of the dose. (auth)

12740 SYSTEM OF TIME ANALYZERS FOR THE NANOSECOND RANGE. Silaev, A. A. (Moscow State Univ.). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 16: No. 6, 1683-1685 (1973).

Translated from Prib. Tekh. Eksp.; 16: No. 6, 62-64(1973).

In order to determine the angular coordinates of extensive atmospheric showers, a system was developed consisting of six time analyzers of the "vernier" type with a delay-measurement step ~6 nsec and a dynamic range ~400 nsec. Time analysis is carried out only when showers are recorded. (auth)

12741 COUNTER WITH A SCINTILLATOR HAVING A LARGE AREA AND A LIGHTGUIDE MADE OF BRAIDED STRIPS. Budanov, N. P.; Govorkov, B. B.; Dolgalev, V. G.; Kotel'nikov, N. G.; Minarik, E. V.; Plaksin, V. P.; Sergienko, V. I. (Inst. of Physics, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 16: No. 6, 1668-1670(1973).

Translated from Prib. Tekh. Eksp.; 16: No. 6, 50-52(1973).

The construction and fabrication procedure of scintillation counter with a scintillator having the dimensions 50 × 50 × 1 cm and a braided strip lightguide are described. Results are presented of measurements of the uniformity and amplitude resolutions which were obtained using a monochromatic electron beam having an energy of ≈300 MeV. (auth)

12742 RECORDING ALPHA-PARTICLES IN CELLULOSE TRIACETATE. Abdullaev, J.; Murtazaev, Kh.; Perelygin, V. P.; Umarov, G. Ya. (Tashkent State Univ.). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 16: No. 6, 1662-1664(1973).

Translated from Prib. Tekh. Eksp.; 16: No. 6, 45-48(1973).

The peculiarities of the use of polymer foam material—cellulose triacetate—for recording α particles were investigated. The dependence of the diameter of the tracks of α particles on the etching time in NaOH and on alkali concentration was investigated. It is shown that etching in 5.0 to 7.5 N NaOH at a temperature 40°C for 30 to 60 min allows tracks of α particles having energies of up to 2.0 MeV to be revealed. (auth)

12743 HELIUM GEIGER–MUELLER COUNTERS FOR RECORDING SLOW NEUTRONS. Goleva, V. I.; Dmitriev, A. B.; Tsenter, E. M.; Chaikovskii, V. G. Instrum. Exp. Tech. (USSR) (Engl. Transl.); 16: No. 6, 1665-1667(1973).

Translated from Prib. Tekh. Eksp.; 16: No. 6, 48-50(1973).

Geiger–Mueller counters filled with ^{3}He having a high efficiency with respect to slow neutrons are described. Although their sensitivity to γ radiation is lowered in comparison with that of conventional Geiger–Mueller γ counters (for example, STS-6 counters), it remains fairly high. The counters find application in the creation of neutron hygrometers, level meters, and other instruments in which the presence of γ fields does not interfere with the measurements of neutrons. (auth)

12744 TELESCOPE OF OPTICAL SPARK CHAMBERS FOR MEASURING THE POLARIZATION OF PROTONS. Derebchinskii, A. I.; Tonapetyan, S. G.; Konovalov, O. G.; Tenishev, A. E. (Physical-Technical Inst., Kharkov). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 16: No. 6, 1650-1652(1973).

Translated from Prib. Tekh. Eksp.; 16: No. 6, 36-38(1973).

A telescope of optical spark chambers is described for measuring the polarization of protons having an energy of 200 to 415 MeV, which has an average proton-scattering efficiency of 7%. The accuracy with which the energy of the scattered protons is measured amounts to ±4.5 MeV. The scattering is performed by carbon blocks and the graphite electrodes of the spark chambers. (auth)

12745 USE OF ONE AMPLITUDE DIFFERENTIAL DISCRIMINATOR FOR THE SIMULTANEOUS MEASUREMENT OF THE RADIOACTIVITY OF SEVERAL SAMPLES. Khait, V. Z.; Shlyukov, A. I. (Moscow State Univ.). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 16: No. 6, 1681-1682(1973).

Translated from Prib. Tekh. Eksp.; 16: No. 6, 60-61(1973).

A method was developed for increasing the productivity of radiometric measurements using the example of recording ^{14}C. The method is based on the time multiplexing of the flows of pulses that arrive simultaneously from several counters and are analyzed by the same amplitude differential discriminator. (auth)

12746 CHARACTERISTICS OF VÉU-1 SECONDARY-ELECTRON MULTIPLIER FOR RECORDING OF LOW-ENERGY ELECTRONS. Kovalenko, V. G.; Polenov, B. V. Instrum. Exp. Tech. (USSR) (Engl. Transl.); 16: No. 6, 1771-1773(1973).

Translated from Prib. Tekh. Eksp.; 16: No. 6, 135-137(1973).

The characteristics of the VÉU-1 secondary-electron multiplier are presented for recording of electrons having energies of 0.04 to 15 keV range in an operating mode in which individual pulses are counted and in the current operating mode. (auth)

12747 PARAMETERS OF AN FEU-110 PHOTOMULTIPLIER IN THE SPECTROMETRIC MODE. Sobornov, O. P.; Shcheglov, O. P. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 16: No. 6, 1768-1770 (1973).

Translated from Prib. Tekh. Eksp.; 16: No. 6, 132-134(1973).

The parameters and characteristics of FÉU-110 (-52M) photomultipliers are investigated for operation with NaI(Tl) and CsI(Tl) detectors. The settling time of the operating mode, the amplitude resolution, and the variation of relative gain of the photomultipliers with a NaI(Tl) crystal are determined within the scope of a batch of 50 devices, as well as the uniformity of the quantum sensitivity of the photocathode (for ten devices). The resulting data are compared with the data of factory tests and with the results of investigations of other types of photomultipliers. (auth)

12748 COMPARISON OF THE CHARACTERISTICS OF ELECTRON MULTIPLIERS WITH LOUVERED AND CONTINUOUS DYNODES. Ainbund, M. R.; Kavalenko, V. G.; Polenov, B. V. Instrum. Exp. Tech. (USSR) (Engl. Transl.); 16: No. 6, 1765-1767 (1973).

Translated from Prib. Tekh. Eksp.; 16: No. 6, 130-132(1973).

A comparison was made of the principal characteristics of louvered VÉU-1 and VÉU-2 electron multipliers and slotted channel electron multipliers with a continuous dynode. (auth)

12749 ENERGY DEPOSITION CHEMICAL TRANSDUCER UTILIZED IN FLUERIC SENSING SYSTEM. Funke, M. F.; Bald, J. F. Jr. (to Secretary of the Army). US Patent 3,812,368. 21 May 1974. Filed date 15 May 1973. 8p.

An apparatus for quantitatively determining the presence of electromagnetic radiation, thermal energy or high energy particles in a controlled environment by exposing certain chemical compounds which generate active chemical species in response to exposure to such electromagnetic radiation, thermal energy or high energy particles is described. The presence of the active or volatile species causes a change in frequency in the output of a flueric oscillator connected to receive a mixture of a power supply fluid and the volatile species. The system includes a second flueric oscillator that has as its single input the power supply gas. The output from the two flueric oscillators are each delivered to a pair of electrical transducers that convert the fluid signals into proportional electrical signals. The electrical signals are fed in turn to readout instrumentation which provides a quantitative comparison of the electrical signals that is directly proportional to the quantity and temperature of the active chemical species and thus, to the level and/or intensity of thermal energy, electromagnetic radiation or high energy particles that produced same. (Official Gazette)

12750 INSTALLATION FOR MEASUREMENT OF THE MAGNETIC MOMENT OF THE EXCITED STATES OF NUCLEI. Begzhanov, R. B.; Gladyshev, D. A.; Muminov, A. I.; Yuldashev, U. (Inst. of Nuclear Physics, Tashkent). Dokl. Akad. Nauk Uzb. SSR; No. 3, 13-14(1974). (In Russian).

An installation designed for the measurement of the magnetic moments by the method of perturbed angular correlation and study of the angular correlation of cascade gamma quanta was constructed. The electronic part is a completely transistorized version of the multichannel systems of fast-slow coincidences. A block scheme of the installation is given and described. Photomultipliers with NaI(Tl) crystals are used as radiation detectors. The efficiency of the installation was verified by measurement of the function of angular correlation of the 329-487 keV cascade and the magnetic moment of the 2083-keV level of ^{140}Ce. Completely satisfactory results were obtained. (JSR)

Radiation Dosimeters

Refer also to abstract 14390.

12751 (UCRL-51393(Rev. 1)) NEUTRON DOSIMETRY (14 MeV) FOR FOIL SAMPLES IRRADIATED WITH THE LAWRENCE LIVERMORE LABORATORY ROTATING TARGET NEUTRON SOURCE. Van Konynenburg, R. A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 24 May 1974. Contract W-7405-eng-48. 16p. Dep. NTIS $4.00.

The Lawrence Livermore Laboratory Rotating Target Neutron Source is being used to irradiate small metal and insulator samples to fluences of about 10^{17} 14-MeV neutrons/cm^2 as part of radiation-damage studies in support of the Controlled Thermonuclear Research materials effort. (The quoted value is the nominal energy; the actual neutron energy depends on geometry and ranges up to 15.6 MeV.) Because of the characteristics of the neutron source, foil activation must be used for accurate dosimetry. Niobium is the material of choice for dosimetry. Present techniques yield an absolute accuracy of 7.5% in fluence for small samples. (auth)

12752 UTILIZATION OF THE ACTIVITY OF BODY-CONTAINED SUBSTANCES IN ACCIDENTAL NEUTRON DOSIMETRY. Schmitt, W. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie; 17: No. 1, 16-20(Jan 1974). (In German).

The application of hair and blood activation to accidental neutron dosimetry is described. In the case of unknown neutron spectrum, because of its spectral error the determination of neutron total absorbed dose is possible only by combining hair and blood activation. (auth)

12753 AN ULTRAHIGH VACUUM ELECTRON SPECTROMETER FOR SURFACE STUDIES. Brundle, C. R.; Roberts, M. W. (Bradford Univ. (UK). School of Chemistry); Latham, D.; Yates, D. (Vacuum Generators Ltd., East Grinstead (UK)). J. Electron Spectrosc. Relat. Phenom.; 3: No. 4, 241-261(Apr 1974).

A high-resolution electron spectrometer has been constructed for the study of clean metal surfaces and their interactions with gases. In its present form it is most suitable for the study of evaporated films but may also be used for ribbons, single crystals, or powders. Electron spectra induced by three sources, X-ray, vacuum ultraviolet, or electron impact, may be recorded sequentially. Electron energy analysis is normally performed by setting the analyzer (10 cm radius, hemispherical) to pass electrons of a fixed energy and applying a scanning retarding potential to the sample. The limiting instrument absolute resolution is about 25 MeV FWHM at 5 eV analyzing energy, as judged by an He I gaseous argon spectrum. Resolution can be traded for sensitivity by analyzing at higher electron energies (up to 100 eV), or by means of an external slit-width adjustment mechanism. The spectrometer carries a preparation chamber which has a variety of demountable sample preparation, cleaning, and reaction monitoring devices. Spectra from gold, silver, and molybdenum films are presented by way of illustration. (auth)

12754 FIRST EXPERIENCES WITH PERSONAL SURVEILLANCE IN RADIOTHERMOLUMINESCENT DOSIMETRY. Laconi, A.; Caffarelli, F.; Brancato, G.; Scopelliti, M. (Univ., Palermo, Italy). Minerva Med.; 64: 3849-3860(20 Oct 1973). (In Italian).

Progress has been made in the last few years in dosimetry based on the use of solid state detectors. The properties of the radiophotoluminescent and thermoluminescent dosimetric systems are analyzed. The dosimeters were examined and tested from the viewpoint of their practical use. Their potential and limitations in the field of personal dosimetry are evaluated in particular. These systems are compared with film dosimetry. It is concluded that although the present status of dosimetric systems can be considered satisfactory with respect to the daily requirements, radiothermoluminescent dosimetry, within certain limitations, can satisfy the majority of the requirements. (tr-auth)

12755 PERSONAL DOSIMETRY SURVEILLANCE WITH RADIOTHERMOLUMINESCENT DOSEMETERS. Laconi, A.; Caffarelli, F.; Brancato, G.; Polizzi, A. (Universita degli Studi, Palermo, Italy). Minerva Med.; 64: 3861-3869(20 Oct 1973). (In Italian).

Increased interest is being displayed in the use of thermoluminescence detectors in personal dose surveillance. Personal experience with pen dosimeters containing manganese-activated calcium fluoride is reported. It is considered that this instrument can usefully be employed as an additional aid along with the personal ionization chamber dosimeter and film badges, particularly since its main feature is the storage of exposure data over long periods of time. (auth)

12756 DEVICES FOR MEASURING THE DOSE RATE OF A BEAM OF IONIZING RADIATION. Boux, R. (to Thomson-CSF). US Patent 3,808,441. 30 Apr 1974. Priority date 30 Apr 1971, France. 4p.

The device, particularly concerned with medical accelerators, comprises two identical ionization chambers, each comprising a pair of insulated semi-circular collector electrodes arranged between two end walls, the insulating strips, separating each said pairs of electrodes being perpendicular to one another, each pair of electrodes being perpendicular to the direction of beam propagation. (Official Gazette)

12757 ^{24}Na INDUCED ACTIVITY AS A NEUTRON DOSIMETER FOR RADIOBIOLOGICAL EXPERIMENTS. Prouza, Z.; Hermanska, J.; Rakovic, M. (Charles Univ., Prague). Isotopenpraxis; 10: No. 4, 156-159(Apr 1974).

Measurement of the ^{24}Na induced activity as a part of a dosimetric system for radiobiological experiments was found to be an approach characterized by its proper reliability, reproducibility (relative error less than 8.5%) and high sensitivity (activities of about 0.01 μCi may be detected). (auth)

12758 PARAMETERS OF A WALL-LESS IONIZATION CHAMBER FOR MEASUREMENT OF LOW DOSAGE POWERS OF LOW-ENERGY X RADIATION. Antipenkova, G. N.; Bregadze, Yu. I.; Muratov, N. I. (All-Union Scientific-Research Inst. of Physicotechnical and Radio-Engineering Measurements, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 16: No. 6, 1817-1819 (1973).

Translated from Prib. Tekh. Eksp.; 16: No. 6, 171-173(1973).

Results are described of an experimental investigation of the parameters of a well-less ionization chamber that is designed for measurement of a low $\sim 10^{-7} - 10^{-2}$ R/sec exposure-dosage powers of x radiation having an energy ranging from 5 to 90 keV. (auth)

12759 FUNDAMENTAL STUDIES ON THERMOLUMINESCENCE DOSIMETRY. I. Glow Curves of TL Phosphors. Nishidai, T.; Onoyama, Y.; Abe, M.; Takahashi, M.; Suyama, S. (Kyoto Univ.). Nippon Igaku Hoshasen Gakkai Zasshi; 33: No. 11, 877-888(Sep 1973). (In Japanese).

For certain TLD phosphors, the TL as a function of exposure is nonlinear in a useful dosimetry range. The change of the glow curves at the different exposure levels was discussed previously. In this study, the glow curves of irradiated phosphors which were previously exposed and heated were measured. It was found that the main cause of the supralinearity was the creation of additional trapping sites by irradiation and that the supralinearity could be eliminated by previous exposure or pre-irradiation annealing. (auth)

12760 ENHANCEMENT OF THE UV SENSITIVITY OF ALUMINIUM OXIDE BY GAMMA RADIATION. Cooke, D. W. (West Virginia Univ., Morgantown). Health Phys.; 27: No. 1, 130-132(Jul 1974).

In an attempt to further develop the uv dosimeter utilizing the TL of sapphire, the effects of γ radiation on the sensitivity of Al_2O_3 crystals doped with chromium and titanium has been investigated. From the date obtained it is apparent that the uv sensitivity of the impurity-doped Al_2O_3 crystals can be enhanced by exposing the crystals to γ radiation prior to the uv exposure. This would enable the uv dosimeter to measure low levels (0.1 μW/cm^2) of uv radiation and should make it a competitive uv radiation dosimeter. (UK)

12761 GAMMA DOSE INTEGRATION SYSTEM USING MINIATURE IONIZATION CHAMBERS. Carr, J. R.; Rich, R. R. (Walter Reed Army Inst. of Research, Washington, DC). Health Phys.; 27: No. 1, 134-137(Jul 1974).

A small ionization chamber which, when located appropriately, allows a reactor operator to monitor the dose rate and total dose delivered to an experiment, is described. The ionization chamber used is constructed from magnesium and polystyrene and is filled with carbon dioxide. The chamber offers minimal perturbation of the radiation field due to its size. A block diagram of the system is shown. The versatility of the system is such that it can be calibrated for use in any range desired by an investigator from 0 to 10^2 rads up to 0 to 10^6 rads. (UK)

12762 SUBMINIATURE DIGITAL RATEMETER USING MOS TECHNOLOGY. Sinclair, K. F. (Xetex, Inc., Redwood City, CA); Heiman, W. J. Health Phys.; 27: No. 1, 97-102(Jul 1974).

The desirability of unambiguous digital display is generally accepted and, as a result, much of today's instrumentation features this approach. While some efforts have been made to incorporate digital displays in portable radiation detection devices, the approach generally used has been to add on an analog-to-digital converter. The result is a bulky and heavy device with short battery life and all of the inherent instability and response problems of analog instruments. A new approach to digital portable radiation instrumentation is discussed that eliminates the problems cited, and makes it possible to produce reliable, low cost instruments. Two wide-range, subminiature monitors have been developed using MOS/LSI components. These are a personal integrating dosimeter and a β-γ ratemeter. The all-digital logic employed results in devices with excellent stability and battery-life characteristics. The dosimeter covers the range from 1 to 9999 mR, and the ratemeter from 0.1 mR/hr to 99.9R/hr with no range switching required. Two different displays are used: a four-digit electro-mechanical register in the dosimeter, and a three-digit LED in the ratemeter. A discussion of the circuit philosophy used, the human factors aspects of each design, and some preliminary performance data are included. (auth)

12763 ANOTHER METHOD OF CALIBRATION FOR LOW ENERGY X-RAY BEAMS. Pychlau, P. (Physikalisch-Technische Werkstaetten, Freiburg i. B.). Phys. Med. Biol.; 19: No. 3, 386 (May 1974).

Brief note is made of the arrangement of a PTW soft radiation chamber for the calibration of low energy x-ray beams. The saturation of the chamber was above 99% up to 1000 Rs^{-1} if operated at 150 V and up to 5000 Rs^{-1} at 300 V. It is pointed out that as the measuring volume of the chamber is 1 mm in depth, there is no change in calibration factor for focus distances between 10 and 100 cm. The chamber was designed for use with bremsstrahlung spectra from a 10 kV beryllium window to 100 kV 2 mm aluminium filter. The variation of the chamber factor in this energy range was <+3%. The chamber has been used in a phantom of perspex plates to measure depth dose distributions, tissue half value depth, etc, in steps of 1 mm. (UK)

12764 FUNDAMENTAL STUDIES ON THERMOLUMINESCENCE DOSIMETRY. II. The Linearity of the Response Curve; the Cause of Supralinearity. Nishidai, T.; Onoyama, Y.; Abe, M.; Takahashi, M.; Suyama, S. (Kyoto Univ.). Nippon Igaku Hoshasen Gakkai Zasshi; 33: No. 11, 889-902(Sep 1973). (In Japanese).

It is convenient to be able to produce glow curves for situations when changes in the phosphor are suspected or for a research involving the TL phenomena. This investigation deals with several factors which have an influence on glow curves. Glow curves were narrowed with an increase in the heating rate. The temperature of the glow peak and the peak height varied with the peak intensities, the shape of the glow curve and the heating apparatus. The absolute and relative heights of the peaks were changed by pre-irradiation annealing at a given temperature. This effect was different in each TL phosphor and depended on annealing times and cooling rates. Some of the phosphors have several shallow traps. It takes about two days to empty the traps at the room temperature. With the fading of response, the main peak is reduced. For some TLD materials, changes in the shape of the glow curve occur at different exposure levels. The amounts of TL as a function of exposure are nonlinear at the exposure levels which produce changes of the glow curves. It was found that the change in the glow curve had a relationship with the occurrence of the supralinearity. (auth)

Nuclear Spectroscopic Instrumentation

Refer also to abstract 14338.

12765 (AREAEE-180) ASSEMBLY AND CALIBRATION OF AN ANTICOMPTON GAMMA-RAY SPECTROMETER USING A Ge(Li) DETECTOR AND AN ANNULAR NaI(Tl) CRYSTAL. El-Kady, A. A.; Eissa, E. A.; Abu-Zeid, H. M.; Rofail, N. B.; Tolechenkov, D.; Hamouda, I. (Atomic Energy Establishment, Cairo (Egypt)). 1973. 15p. Dep. NTIS (U. S. Sales Only) $4.00.

A gamma-ray spectrometer that uses a 30cc true coaxial lithium-drifted germanium detector Ge(Li) and a 4 sector annular 8 × 8 inch sodium iodide crystal to operate in the Compton suppression mode at low γ-ray energies is described. The optimum energy resolution of the spectrometer is approximately 4 keV (FWHM) at the 1.274 MeV gamma-ray line of ^{22}Na. The continuous Compton background of the ^{22}Na gamma-ray is reduced on the average by a factor of about 3.5 while the Compton edges are reduced only by a factor of about 2.5. The single and double escape peaks of the 2614 keV gamma-ray from ^{232}Th are suppressed to about 56% and 35% respectively. No appreciable reduction in the intensity of the full-energy peaks was realized. The data were obtained using 4 standard radioactive sources, namely ^{137}Cs, ^{22}Na, ^{232}Th and ^{182}Ta. The set-up was prepared for use in conjunction with the 2-MW nuclear reactor for obtaining thermal neutron capture gamma spectra of elements over the low energy range. (auth)

12766 (EUR-5121-d) INTERFACE FOR THE CONTROL OF A MULTICHOPPER FACILITY. Eder, J.; Brak, H. (Commission of the European Communities, Ispra (Italy). Joint Nuclear Research Center). 1974. 37p. (In German). Dep. NTIS (US Sales Only) $4.00. BF 40,-.

An interface for the coupling of a multi-chopper facility to a computer has been developed, which provides program controlled settings of rotor speed (period time) and phase angle (delay) of 4 chopper drives. Moreover up to 8 operating values from the choppers (period, delay) can be checked under program control and transmitted to the computer. (auth)

12767 (FRNC-CONF-93) ULTRA-PURE GERMANIUM BASED NUCLEAR DETECTORS. Ponpon, J. P.; Siffert, P. (Centre National de la Recherche Scientifique, 67-Strasbourg (France). Lab. de Physique des Rayonnements et d'Electronique Nucleaire). 7 May 1973. 25p. (In French). (CONF-730557-5). Dep. NTIS (US Sales Only) $4.25.

From meeting for studies of gamma spectrometry; Grenoble, France (7 May 1973).

The detection of γ radiation with germanium based spectrometers necessitates large sensitive (charge space zone) volumes. Up until comparatively recently, this type of depleted region was obtained by compensating the impurities contained in P type material by migrating lithium ions. Progress recently accomplished in the purification of germanium has enabled the compensation process to be avoided, thus rendering a more rapid fabrication of room temperature stable counters. A summary of the work carried out in conjunction with this new type of detector is presented. The characteristics of the initial materials are described. The various methods used to fabricate the counters are then presented. The performance of these detectors in γ-ray spectrometry is then discussed. (FR)

12768 (INIS-mf-1264) NEUTRON SPECTRUM MEASUREMENTS WITH PLASTIC SCINTILLATOR. Sarkar, P. K.; Kirthi, K. N. (Bhabha Atomic Research Centre, Bombay (India). Health Physics Div.). 1973. 8p. INIS.

From first annual conference of Indian Association for Radiation Protection; Bombay, India (12 Apr 1973).

Unfolding of the neutron spectrum is attempted with a single scattering model using different scintillator thicknesses. The calculation adopted in the present work for unscrambling the neutron spectrum from the proton recoil distribution is simple enough to be computed by hand calculations. A computer program PROSPEC is used. Gamma discrimination is not done by conventional pulse shape discrimination. A Monte Carlo code COMSCAT takes care of the elimination of gamma background and also of Compton calibration. (auth)

12769 SENSITIVE DETECTION SYSTEM FOR SOFT X-RAY APPEARANCE POTENTIAL SPECTROSCOPY. Chamberlain, M.B.; Baun, W.L. (Air Force Materials Laboratory (MBM), Dayton, Ohio 45433). Rev. Sci. Instrum. 45: No. 4, 545-547 (Apr 1974).

A sensitive x-ray detection system has been used in the recording of soft x-ray appearance potential spectra with an electron excitation current of a few microamperes covering a sample area of 1 cm^2. The system included a 6μ thick aluminum foil, a cesium iodide photocathode, a continuous-channel electron multiplier, and conventional pulse-counting electronics. The aluminum foil was placed over the entrance window of the detector in order to filter out the ultraviolet and extreme-soft x-ray emissions from the sample prior to detection of the soft x rays that passed through the foil. The transmitted soft x rays were incident on a cesium iodide photocathode and the resulting photoelectron events were individually detected with a high-gain electron multiplier whose output pulses were processed with pulse-counting electronics. (auth)

12770 A TIME-OF-FLIGHT DETECTION SYSTEM FOR NEAR THRESHOLD PHOTOELECTRON SPECTROSCOPY. Tsai, B.; Baer, T.; Horovitz, M.L. (William R. Kenan Jr. Laboratory of Chemistry, University of North Carolina, Chapel Hill, N.C. 27514). Rev. Sci. Instrum. 45: No. 4, 494-498 (Apr 1974).

A time-of-flight detection system and apparatus have been developed to obtain photoelectron spectra for electron energies between 0 and 1 eV. This method has the advantage of collecting and analyzing photoelectrons of all energies simultaneously and therefore compensating for low signal levels due to low light intensities or small ionization cross sections. The collection efficiency and energy resolution are highest for electrons with near zero kinetic energy ($\lesssim$100 meV). This technique has made it possible to obtain photoelectron spectra with a continuum light source dispersed by a monochromator. It is thus particularly useful for the study of autoionization events. Also presented are calculated potentials in 3-dimensional rectangular acceleration regions and the effect of initial kinetic energy on space focusing in nonconstant electric fields. (auth)

12771 RESOLUTION AND CHANNEL WIDTH IN γ SPECTROSCOPY. Van Damme, K. J. Polytech. Tijdschr., Elektrotech./Electron.; 29: No. 3, 80-83(6 Feb 1974). (In Dutch).

The width of a peak is defined as the full width between the half maximum positions. The energy distribution within a peak formed by γ quanta follows a Gaussian law and graphs are given of resolving power against channel width as calculated on this basis. If the channel width does not exceed about 0.5 of the peak width, the resolving power is only about 10% less than in the limiting case of zero channel width. This is verified by experiment. (NL)

12772 REPLY TO "γ-RAY SPECTROMETER PROBE FOR THE MEASUREMENT OF RADIOACTIVE POLLUTION IN THE SEA" BY CH. WEDEKIND. Riel, G. (Naval Ordnance Lab., Silver Spring, MD). Health Phys.; 26: No. 6, 584(Jun 1974).

Comments are made on the work of Dr. Wedekind on γ-ray spectrometers (Health Phys.; 25: 51(1973)) which cover the lead shielding employed, sources of background radiation and standardization of the detector. Names and addresses are given of other workers in this field. (UK)

12773 SPECTROMETRIC PARAMETERS OF CsI(Tl) AND CsI(Na) CRYSTALS. Sobornov, O. P.; Shcheglov, O. P. (Inst. of Geochemistry and Analytic Chemistry, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 16: No. 6, 1671-1673(1973).

Translated from Prib. Tekh. Eksp.; 16: No. 6, 53-55(1973).

The spectrometric parameters of CsI(Tl) and CsI(Na) crystals, which are distinguished by their moisture resistance and better mechanical properties than the NaI(Tl) crystals which are usually employed, were investigated. Photoelectron multipliers of various types, including new FEU-110 (52 M) photomultipliers having multialkaline cathodes, were used in the work. With CsI(Tl) crystals, a resolution of ~8.6% was achieved. It was possible to create spectrometric detection blocks with the crystals that were suitable for operation under conditions of considerable mechanical loads. (auth)

12774 A MAGNETIC SPECTROMETER SYSTEM FOR ON-LINE STUDIES OF β RAYS AND INTERNAL CONVERSION ELECTRONS OF SHORT-LIVED MASS-SEPARATED ACTIVITIES. Halbig, J.K.; Wohn, F.K.; Talbert, W.L., Jr. (Ames Laboratory-USAEC and Department of Physics, Iowa State University, Ames, Iowa 50010). Rev. Sci. Instrum. 45: No. 6, 789-797 (June 1974).

A $\pi\sqrt{2}$ high-resolution magnetic spectrometer has recently become operational at the TRISTAN on-line isotope separator facility. The design and operational modes of the spectrometer have been developed especially for on-line studies of short-lived mass-separated fission product activities. The spectrometer configuration is described, with particular emphasis on the magnetic field control and stabilization, the data collection modes and techniques developed to study nonequilibrium source activities, and the stabilization of the ion-beam deposit position by use of a split-tape ion-beam collector. (auth)

12775 THERMODYNAMIC PROPERTIES OF BORON TRIOXIDE IN THE GLASS TRANSITION REGION. Corsaro, R.D.; Jarzynski, J. (Naval Research Laboratory, Washington, D.C. 20375). J. Chem. Phys. 60: No. 12, 5128-5129 (15 June 1974).

The equilibrium expansitivity and compressibility have been measured for a B_2O_3 glass specimen in the temperature range 568-627°K. (AIP)

12776 ENERGY DISPERSION X-RAY ANALYSIS: X-RAY AND ELECTRON PROBE ANALYSIS. Seventy-third Annual Meeting of the American Society for Testing and Materials, Toronto, Ontario, June 21-26, 1970. Russ, J. C. Philadelphia; American Society for Testing Materials (1971). 290p. (ASTM-STP-485; CONF-700683-). $20.00.

Separate abstracts were prepared for the 13 papers presented at the symposium). (WHK)

For abstracts of individual papers see: 12777-12785 and 12829-12832.

12777 X-RAY ENERGY SPECTROMETRY IN THE 0.1 TO 10 A RANGE. Fitzgerald, R. (Univ. of California, San Diego, La Jolla); Gantzel, P. pp 3-35 of Energy Dispersion X-ray Analysis: X-ray and Electron Probe Analysis. Russ, J. C. Philadelphia; American Society for Testing and Materials (1971).

From symposium on energy dispersion x-ray analysis: x-ray and electron probe analysis; Toronto, Ont, Canada (21 Jun 1970). See ASTM-STP-485; CONF-700683-.

Energy spectrometry utilizing a solid-state detector (silicon) for x-ray elemental analysis is described, and compared with wavelength spectrometry. Parameters which influence the spectrometer energy resolution, energy detection range, and count rate capabilities are reviewed. Measured performance of a spectrometer (200 eV FWHM resolution for 6.404 keV radiation) is demonstrated for both x-ray and electron specimen excitation. (auth)

12778 FUTURE OF SILICON X-RAY DETECTORS. Aitken, D. W. (San Jose State Coll., CA); Woo, E. pp 36-56 of Energy Dispersion X-ray Analysis: X-ray and Electron Probe Analysis. Russ, J. C. Philadelphia; American Society for Testing and Materials (1971).

From symposium on energy dispersion x-ray analysis: x-ray and electron probe analysis; Toronto, Ont, Canada (21 Jun 1970). See ASTM-STP-485; CONF-700683-.

The future potential for silicon x-ray detectors is appraised in view of recent accomplishments, present trends, and present physical knowledge. The discussion includes achievements in resolution with both small and large area detectors, and at both low and high count rates. Differences are emphasized between theoretical capability and experimental practicality, with the dual aim of helping the experimenter to evaluate the potential of silicon x-ray spectrometers in his own work, and of guiding him toward experimental design concepts that might enable him to make the maximum use of the available electronic and detector performance capabilities. The present advantages of silicon over germanium for x-ray energies below about 40 keV are discussed. (auth)

12779 LOW-NOISE CRYOGENIC PREAMPLIFIERS. Elad, E. (ORTEC, Inc., Oak Ridge, TN). pp 57-81 of Energy Dispersion X-ray Analysis: X-ray and Electron Probe Analysis. Russ, J. C. Philadelphia; American Society for Testing and Materials (1971).

From symposium on energy dispersion x-ray analysis: x-ray and electron probe analysis; Toronto, Ont, Canada (21 Jun 1970). See ASTM-STP-485; CONF-700683-.

Low-noise cryogenic preamplifiers for semiconductor x-ray detectors are described. The basic structure of field-effect transistor (FET) preamplifier and its major parameters in the context of the x-ray spectrometer is presented. Operational characteristics of an FET and its noise properties, especially at cryogenic temperatures, are outlined. Noise frequency response requiring band-pass limitations and their achievement through pulse shaping in the main amplifier is described. Noise formulation is presented emphasizing the influence of various parameters and the conflicting requirements of low-noise and high count-rate performance. Various feedback schemes are described, comparing in particular the noise and count-rate characteristics of the opto-electronic and the resistive feedback configurations. Recent experimental results with silicon and germanium spectrometers are given and compared with the theoretical limitations. Finally, future possibilities in the development of x-ray energy analyzers are assessed. (auth)

12780 CHARACTERIZATION OF SEMICONDUCTOR X-RAY ENERGY SPECTROMETERS. Walter, F. J. (ORTEC, Inc., Oak Ridge, TN). pp 82-112 of Energy Dispersion X-ray Analysis: X-ray and Electron Probe Analysis. Russ, J. C. Philadelphia; American Society for Testing and Materials (1971).

From symposium on energy dispersion x-ray analysis: x-ray and electron probe analysis; Toronto, Ont, Canada (21 Jun 1970). See ASTM-STP-485; CONF-700683-.

The important performance parameters of a semiconductor x-ray energy spectrometer and the standardized techniques for measuring and documenting most of the related specifications are described. The strong coupling between performance parameters such as energy resolution, detector size (efficiency), count-rate capability, and general spectral integrity (tailing, etc.) is detailed. In particular, the conflict between the need to improve energy resolution by increasing the amplifier shaping time constants (that is, minimizing field-effect transistor noise) and the need to improve count-rate capability by decreasing amplifier pulse shaping time constants are examined thoroughly. Since, as is shown, most performance parameters can be improved at the expense of other characteristics, the importance of providing enough test data to determine the trade-off cost involved in optimizing a particular variable is emphasized. (auth)

12781 ROLE OF MULTICHANNEL ANALYZER IN DATA HANDLING. Williams, G. (Northern Scientific, Inc., Middleton, WI). pp 125-139 of Energy Dispersion X-ray Analysis: X-ray and Electron Probe Analysis. Russ, J. C. Philadelphia; American Society for Testing and Materials (1971).

From symposium on energy dispersion x-ray analysis: x-ray and electron probe analysis; Toronto, Ont, Canada (21 Jun 1970). See ASTM-STP-485; CONF-700683-.

The multichannel analyzer role in x-ray spectrometer analysis has been taking on an ever increasing importance. Complete energy spectra observations are now possible from a single scan of a specimen with electron microscope. The scope of this paper will be to interpret these spectral data in terms of accuracy, parameters, and usefulness to the x-ray spectrometer user. A set of general specifications will be outlined for the multichannel analyzer to cope with the ever changing requirements of the user and developments of the manufacturer. With this aid it is the hope that the users of the multichannel analyzers will be able to incorporate units in their system that will perform the present and future functions of their applications. (auth)

12782 SOLID-STATE X-RAY DETECTORS FOR ELECTRON MICROPROBE ANALYSIS. Lifshin, E. (General Electric Co., Schenectady, NY). pp 140-153 of Energy Dispersion X-ray Analysis: X-ray and Electron Probe Analysis. Russ, J. C. Philadelphia; American Society for Testing and Materials (1971).

From symposium on energy dispersion x-ray analysis: x-ray and electron probe analysis; Toronto, Ont, Canada (21 Jun 1970). See ASTM-STP-485; CONF-700683-.

Semiconducting x-ray detectors with low noise and high resolution have recently become available for the less than 20 keV range which is the region of interest encountered in the examination of x-rays produced in the electron microprobe analyzer. Although their energy resolution is generally less than that of crystal spectrometers, they offer special advantages including simultaneous collection of all detectable x-ray signals, high collection efficiencies, wavelength measurement independent of specimen position, and rapid collection of data in a form compatible with computer processing. Added to an electron microprobe, they provide a method of detecting in several minutes all elements with atomic number greater than sodium and present in quantities as small as a few tenths of a percent. Quantitative analyses are possible provided care is exercised in evaluating background spectra and peak overlap. (auth)

12783 ENERGY DISPERSION X-RAY ANALYSIS ON THE SCANNING ELECTRON MICROSCOPE. Russ, J. C. (Jeolco, Inc., Medford, MA). pp 154-179 of Energy Dispersion X-ray Analysis: X-ray and Electron Probe Analysis. Russ, J. C. Philadelphia; American Society for Testing and Materials (1971).

From symposium on energy dispersion x-ray analysis: x-ray and electron probe analysis; Toronto, Ont, Canada (21 Jun 1970). See ASTM-STP-485; CONF-700683-.

The scanning electron microscope is similar in many respects to the electron probe analyzer, but the scanning electron microscopist has a different goal and examines different specimens. The very low beam current of the scanning electron microscope requires the higher efficiency of the energy dispersion spectrometer (as compared to the wave-length dispersion type) resulting from a large solid angle, virtually 100 percent detection efficiency, and simultaneous analysis of all elements. Another advantage is that there is no confusion of lines due to the order of diffraction from a crystal. In examining rough surfaces or when working at low magnification, there is no loss of x-ray intensity because there is no geometric dependence of the energy dispersion detector. At high magnification the energy dispersion detector gives better x-ray resolution because of the smaller incident beam that can be used. The minimum detectable limits are comparable to wave-length spectrometers except for light elements, and quantitative analysis is practical. The modes of display include line scans and x-ray images in addition to point analyses. The paper discusses practical considerations in selecting and operating an energy dispersion x-ray system. (auth)

12784 ENERGY DISPERSION X-RAY ANALYSIS WITH THE TRANSMISSION ELECTRON MICROSCOPE. Bender, S. L.;

Duff, R. H. (Kennecott Copper Corp., Lexington, MA). pp 180-196 of Energy Dispersion X-ray Analysis: X-ray and Electron Probe Analysis. Russ, J. C. Philadelphia; American Society for Testing and Materials (1971).

From symposium on energy dispersion x-ray analysis: x-ray and electron probe analysis; Toronto, Ont, Canada (21 Jun 1970). See ASTM-STP-485; CONF-700683-.

The addition of x-ray emission analysis capabilities to a conventional transmission electron microscope offers a new analytical dimension to the microscopist. The availability of Si(Li) solid-state x-ray detectors with energy resolutions superior to any previous type of x-ray detector provides the microscopist with an efficient system for elemental analysis that does not interfere with normal microscope operation. A commercially available Si(Li) detector has been installed on a transmission electron microscope capable of forming a 1.6-μm-diameter spot at the specimen plane with the following characteristics of operation (a) x-radiation from the specimen, the specimen holder, the mounting grid, and the objective aperture (if in place) are the only signals detected; (b) no degradation of detector resolution by the magnetic fields of the microscope lenses or the proximity of the incident electron beam to the detector (a few millimeters) is observed; and (c) x-ray signals from particles 1000 Å in diameter are detectable with peak-to-background ratios of about two. (auth)

12785 ROLE OF THE GAS FLOW PROPORTIONAL COUNTER IN ENERGY DISPERSIVE ANALYSIS. Sutfin, L. V.; Ogilvie, R. E. (Massachusetts Inst. of Tech., Cambridge). pp 197-216 of Energy Dispersion X-ray Analysis: X-ray and Electron Probe Analysis. Russ, J. C. Philadelphia; American Society for Testing and Materials (1971).

From symposium on energy dispersion x-ray analysis: x-ray and electron probe analysis; Toronto, Ont, Canada (21 Jun 1970). See ASTM-STP-485; CONF-700683-.

A comparison of the gas flow proportional counter and the Si(Li) solid-state detector is made. Currently the flow proportional counter provides a means of extending the range of energy dispersive analysis to the region below 1 keV. It also can be used where the rigid environmental requirements of solid-state detectors cannot be met. The inherent statistical fluctuations of the ionization processes involved determine the ultimate resolution of gas counters, and this is inferior to that of the Si(Li) detector. Since energy analysis in the low energy region is more difficult than in the region above 1 keV, the solid-state detector appears to be worth developing for operation over the entire range. (auth)

12786 LATEST DEVELOPMENT OF MOESSBAUER SPECTROMETER. Fujio, Y. (Shimadzu Seisakusho Ltd., Kyoto). Radioisotopes (Tokyo); 22: No. 7, 386-394(Jul 1973). (In Japanese).

It seems on the basis of recent development that Mössbauer spectrometry is forming its own field. The velocity modulators for spectrometers are required to provide necessary performance in Doppler velocity resolution which is determined by calculation for each nuclide. As for γ detectors, Ge(Li) semiconductor detectors have been commercially available, and are being employed because of their high resolution over 100 keV range. Also, measuring methods have been contrived for calibrating velocity and for measurement under extreme conditions. Though the measurement of the Mössbauer effect is usually practiced by the transmission method, the measurement of the Mössbauer effect by "scattering" has begun to be applied to the measurement of internal conversion electrons and characteristic x-rays. Lately, Jacobs,et al. measured the Mössbauer effect of Hf compounds by the use of Coulomb excitation. (JA)

12787 APPLICATION OF PULSE SHAPE DISCRIMINATION TO LIQUID SCINTILLATION ALPHA SPECTROSCOPY. Thorngate, J. H.; McDowell, W. J.; Christian, D. J. (Oak Ridge National Lab., TN). Health Phys.; 27: No. 1, 123-126(Jul 1974).

To reduce the background counts in liquid scintillation α spectroscopy, pulse shape discrimination to separate alpha and electron produced pulses has been used. The technique measures the shape of the output of the linear amplifier by measuring the time from the start of the pulse to some point on its fall. Using a time-to-pulse-height conversion allows the distribution of the length of the pulses to be recorded on a multi-channel analyzer, a major convenience in setting the discrimination level. Such a display is shown on which are two peaks, one produced by the electron interactions with the scintillator and the other due to the α interactions. Discrimination is obtained by having the multichannel analyzer record the pulse height spectrum of only those pulses that are in the peak due to the α interactions. (UK)

High Energy Physics Instrumentation

Refer also to abstracts 13345 and 13873.

12788 (CERN-Trans-74-1) DYNAMICS OF A VAPOR BUBBLE IN HELIUM AND HYDROGEN ULTRASONIC CHAMBERS. Tkachev, L. G.; Shestakov, V. D. (Joint Inst. for Nuclear Research, Dubna (USSR)). Mar 1974. Translation by N. M. Harigel and G. Harigel of JINR-P13-7206. 12p. Dep. NTIS (US Sales Only) $4.00.

The results are presented of experimental and theoretical investigations of track formation in a liquid-hydrogen bubble chamber in the ultrasonic field. Different physical phenomena are considered characterizing the dynamics of the vapor pockets. The dynamics of the nucleating bubble is studied: cavitation and diffusion thresholds are determined as well as the dependence on the initial phase and surface tension. (auth)

12789 (EFI-22-73) PERFORMANCE OF THE TELEVISION SYSTEM FOR FILMLESS SPARK CHAMBERS IN THE ELECTRON RING ACCELERATOR BEAM. Klevaltn, V. A.; Lebedev, B. A.; Ivanchikhin, A. F.; Petrakov, A. V.; Dadyan, A. T.; Zverev, V. M.; Lebedev, Yu. N.; Mozharov, Yu. N.; Kharitonov, V. M. (Erevanskij Fizicheskij Inst. (USSR)). 1973. 22p. (In Russian). INIS.

Results are presented on an operational study of an automatic television system for taking information with spark chambers (STASIK) on the beam of the EREVAN electron-ring accelerator in line with a PDP-9 digital computer. The following results were obtained: the error in measuring the coordinates of a reference marker was 2.0 to 2.3×10^{-4} of the line length; the error in measuring the coordinate of a separate track in the spark chamber was 4.5 to 6×10^{-4}; the error in measuring the coordinates of tracks in a multitrack mode of operating the spark chamber was 5 to 10×10^{-4}; the efficiency and sensitivity were not worse than the photomethod and were sufficient for registering weak tracks at a diaphragm of 5.6 to 8. (SJR)

12790 (EFI-43(73)) MONTE CARLO CALCULATION FOR X-RAY TRANSITION RADIATION DETECTOR BASED ON THE ENERGY DEPOSITION METHOD. Zverev, A. M.; Ispiryan, K. A.; Margaryan, A. T. (Erevanskij Fizicheskij Inst. (USSR)). 1973. 23p. (In Russian). Dep. NTIS (US Sales Only) $4.25.

Various characteristics of x-ray transition radiation detectors are calculated by the Monte Carlo method using the results of the transition radiation theory in a stack of plates. The results are compared with experimental data. (auth)

12791 (KFK-1936) PROPERTIES OF A HADRON CALORIMETER USED AS A NEUTRON SPECTROMETER IN AN ISR-EXPERIMENT. Hanke, P.; Isenbeck, W.; Moritz, J.; Schmidt, K. H.; Wegener, D. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Experimentelle Kernphysik). Mar 1974. 23p. Dep. NTIS (U. S. Sales Only) $4.25.

The energy dependence of the pulse height, the resolution and the efficiency of a total absorption neutron calorimeter has been measured for particle energies 3 GeV < T_{kin} < 21 GeV. There are indications that the response and the resolution of the detector are influenced by the number of particles produced in the first nucleon-nucleus interaction of the shower process. (auth)

12792 (LA-5609-MS) DATA ACQUISITION SOFTWARE FOR A MWPC SPECTROMETER. Hiebert, J. C.; Niethammer, A. C. (Los Alamos Scientific Lab., N. Mex. (USA)). May 1974. Contract W-7405-eng-36. 25p. Dep. NTIS $4.00.

Program DAISY-11 is a flexible software package written to provide the operations necessary for data acquisition, on-line analysis, and operator control during a series of nucleon-nucleon experiments to be done at the Los Alamos Meson Physics Facility (LAMPF) Nucleon Physics Laboratory. The final results of the on-line reduction are stored on a disk master file with unprocessed data being stored directly onto magnetic tape in a format suitable for final detailed analysis on LASL's CDC-7600 computers. Intermediate capabilities provide the experimenter with a variety of plotting and listing options, one-parameter and two-parameter histogram displays, and operator control during the experiment. (auth)

12793 PERFORMANCE OF A SPARK CHAMBER ASSEMBLY. Shamsudduha, A. K. M. (Birbeck Coll., London). Indian J. Phys.; 47: No. 12, 705-717(Dec 1973).

A spark chamber assembly specially designed to investigate the properties of cosmic rays underground has been described and its performance evaluated. The efficiency for single particle was found to be 98% decreasing to about 91% for six simultaneous tracks. The standard deviation of the sparks from the fitted trajectory was found to increase with increasing track angle from about 0.09 mm

for vertical tracks to about 0.30 mm for tracks at 30° to the vertical. Analyses of the results showed that the most important parameter in the performance of the spark chamber is the achievement of short spark formation time. (auth)

12794 MULTIWIRE PROPORTIONAL COUNTER. Tait, W. H. (North East London Polytechnic). J. Inst. Nucl. Eng.; 15: No. 2, 47-52(Mar 1974).

The most important properties of the MWPC are reviewed. It is still under development, but already finds widespread use in high energy physics. Its major disadvantage is high cost. Its major advantage is that it simultaneously measures energy and position. Its potential for further improvement is considerable. (auth)

12795 COMPOSITE CHERENKOV TOTAL-ABSORPTION SPECTROMETER. Belousov, A. S.; Malinovskii, E. I.; Rusakov, S. V.; Tamm, E. I.; Shareiko, P. N. (Inst. of Physics, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 16: No. 6, 1645-1647(1973).

Translated from Prib. Tekh. Eksp.; 16: No. 6, 33-35(1973).

A composite Cherenkov total-absorption spectrometer was fabricated for the spectrometry of electrons having energies amounting to tens of GeV. The spectrometer consists of two Cherenkov counters that are positioned one behind the other. A radiator consisting of a KRS-6 single crystal 12 X_0 thick was mounted in the first counter, while the radiator of the second counter consisted of lead glass 10 X_0 thick. The pulses from the counters are added linearly. Calibration of the spectrometer by electrons having energies ranging from 26 to 45.5 GeV demonstrated good linearity throughout the entire range and an energy resolution of 3%. (auth)

12796 UNIVERSAL MODULAR SYSTEM OF SPARK CHAMBERS. Agan'yants, A. O.; Vartapetyan, G. A.; Kazaryan, G. Kh.; Lebedev, A. N.; Khudaverdyan, A. G. (Inst. of Physics, Erevan). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 16: No. 6, 1648-1649(1973).

Translated from Prib. Tekh. Eksp.; 16: No. 6, 35-36(1973).

Narrow-gap unitized spark modules with electrodes made of thin foil are described, from which one can assemble coordinate, transit, and shower chambers, as well as target chambers. The technology for fabricating these modules is presented. The advantages of such detectors are discussed. A scheme for evacuating and filling the modules is likewise presented. (auth)

12797 PROPERTIES OF A SPARK CHAMBER FOR OPERATION AT A FREQUENCY OF UP TO 100 Hz. Aref'ev, A. V.; Leksin, G. A.; Suchkov, D. A.; Fedorov, V. B. (Inst. of Theoretical and Experimental Physics, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 16: No. 6, 1653-1654(1973).

Translated from Prib. Tekh. Eksp.; 16: No. 6, 39-40(1973).

The operation of a spark chamber in a magnetic field having a frequency of up to 100 Hz was studied. It was shown that the dead time of a chamber containing a Ne + He filler is <10 msec, while the efficiency with which the second track is recorded for successive passage of two particles in the chamber is independent of the magnitude of the magnetic or purifying fields. (auth)

12798 ANALYSIS OF THE ELECTROMAGNETIC DRIFT OF SPARKS IN A SPARK CHAMBER. Dukhovskoi, I. A.; Radkevich, I. A. (Inst. of Theoretical and Experimental Physics, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 16: No. 6, 1655-1658(1973).

Translated from Prib. Tekh. Eksp.; 16: No. 6, 40-43(1973).

An experimental investigation was made of the dependence of the displacement of sparks in a spark chamber on the electrical purifying field in the E/P range from 0.04 to 0.3 V $cm^{-1} \cdot torr^{-1}$ and on the magnetic induction in the range from 0 to 1.7 T. A noticeable deviation from results obtained earlier was revealed. A comparison was made between the computer data and experimental results for pure Ne and an Ne + He mixture. (auth)

12799 INVESTIGATION OF A STREAMER CHAMBER CONTAINING XENON. Belyakov, E. S.; Lorikyan, M. P.; Markaryan, K. Zh.; Shikhlyarov, K. K. (Inst. of Physics, Erevan). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 16: No. 6, 1659-1661(1973).

Translated from Prib. Tekh. Eksp.; 16: No. 6, 43-45(1973).

A streamer chamber with an Xe admixture was investigated. The dependence of the number of streamers on Xe concentration and on the number of slow electrons in the chamber is presented. (auth)

12800 METHOD OF SHIELDING CRYOGENIC SURFACES FROM CONTAMINATION BY SOLIDIFIED GASES FOR USE IN A HYDROGEN BUBBLE CHAMBER. D'yachkov, E. I.; Zel'dovich, A. G. (Joint Inst. for Nuclear Research, Dubna, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 16: No. 6, 1820-1822(1973).

Translated from Prib. Tekh. Eksp.; 16: No. 6, 174-176(1973).

A new method for shielding cryogenic surfaces from solidified gases when the surfaces are surrounded by an uncondensed gas is described. The method consists in the fact that a stream of pure uncondensed gas directed opposite to the diffusing impurities is produced in the space near the shielded surface. Using the example of the hydrogen chambers of the JINR, the efficiency of the developed method relative to previously known methods is demonstrated. (auth)

Radiometric Instruments

12801 (AREAEE-190) ANALYSIS OF THE EFFECTS OF ENVIRONMENTAL CHANGES ON RADIOISOTOPIC THICKNESS MEASUREMENTS. Abdel Rahman, F. M.; El-Saiedi, A. F.; Bedair, S. M.; El-Fouly, M. F. (Atomic Energy Establishment, Cairo (Egypt)). 1973. 22p. Dep. NTIS (US Sales Only) $4.25.

A theoretical study of the effects of ambient changes on the sensitivity of thickness gauges for paper using radioisotopes is presented. The study includes general discussions on the parameters affecting the radioisotopic gauges. A relation has been reached relating the detector response to the ratio of signal change to noise ratio, minimum detectable change, and the detector sensitivity. The second part of the report deals with the detailed effects of the ambient conditions on the detector sensitivity. Figures showing such effects are included. (auth)

12802 RADIATION SENSITIVE ENDS DOWN DETECTING APPARATUS AND METHOD. Mulligan, W. L. (to Parks-Cramer Co.). US Patent 3,803,822. 16 Apr 1974. Filed date 14 Dec 1970. 6p.

An apparatus and method for detecting ends of yarn on a textile yarn forming machine such as a spinning machine is described. The radiation source and radiation detector are mounted on and movable with a traveling unit and direct radiation toward the ends of yarn and respond to radiation reflected therefrom. The impingement of radiation onto the detector is amplified at a low signal to noise ratio through concentration of reflected radiation by a static reflector. (Official Gazette)

12803 UNIFIED SYSTEM OF RADIOISOTOPE RELAY DEVICES (USRRD) AND THE PRINCIPLE OF COMPLETING RADIOISOTOPE DEVICES FOR CONTROLLING THE TECHNOLOGICAL PROCESSES. Pozdnikov, V. N.; Polkovnikov, V. K.; Taksar, I. M.; Yanushkovskii, V. A. Izotopy SSSR; No. 26, 3-14(1972). (In Russian).

A system of radioisotopic relays was developed which consists of 28 unified functional blocks. Methods of constructing the equipment, using nomograms, are considered. The chief functional node is an assembly consisting of a source of ionizing radiation, radiation detector, and electron-relay unit. Input to the system is from unified beta and gamma source units, detector assemblies, (gas-discharge, scintillation, and semiconductor), relay blocks, and signal and control blocks. Basic parameters of the radiometric, electric, and construction blocks of the system are presented. (tr-auth)

12804 RADIATION GAUGE. Cho, B. Y.; Sturkol, E. W.; Wier, K. E. (to Industrial Nucleonics Corp.). US Patent 3,809,903. 7 May 1974. Filed date 1 Dec 1971. 8p.

A radiation transmission gage to measure, during manufacture, the low atomic number, nonhomogeneous, large thickness materials, such as fiberglass, using primarily the radiation photoelectric effect is described. The gage source-detector geometry provides monoenergetic x-rays in the 14 to 30 keV range, produced by a primary source of gamma radiation of higher energy, through fluorescence of a target. The radiation detector uses krypton gas and the target material is selected to produce a fluorescence radiation that is above and substantially close to the K-edge of the krypton gas. Other features of the source-detector geometry minimize the presence of the primary source radiation, to improve gauge accuracy. (Official Gazette)

Radiation Effects on Instrument Components, Instruments, or Electronic Systems

Refer also to abstracts 13277 and 14144.

12805 IRRADIATION FOR FAST RECOVERY OF HIGH POWER JUNCTION DIODES. Tarneja, K. S.; Marcinko, F. V. (to Westinghouse Electric Corp.). US Patent 3,809,582. 7 May 1974. Filed date 8 Mar 1973. 8p.

The recovery time of a high power junction diode is substantially reduced and tailored to specific specifications while maintaining within nominal ranges other electrical characteristics and particularly the forward voltage drop of the device. The diode is irradiated preferably with electron radiation which preferably has an intensity between about 1 and 3 MeV. Further preferred, the electron radiation is applied to a dosage level between about 1×10^{12} and 1×10^{14} electrons per cm^2. (Official Gazette)

12806 RAPID ANNEALING OF FREQUENCY CHANGE IN HIGH FREQUENCY CRYSTAL RESONATORS FOLLOWING PULSED X-IRRADIATION AT ROOM TEMPERATURE. King, J. C.; Sander, H. H. (Sandia Labs., Albuquerque, NM). pp 113-119 of Proceedings of the Twenty-Seventh Annual Frequency Control Symposium. Washington, DC; Electronic Industries Association (1973).

From 27th annual frequency control symposium; Cherry Hill, New Jersey, USA (12 Jun 1973). See CONF-730622-.

Measurements have been made of the frequency of 32-MHz and 125-MHz AT-cut 5th overtone natural, Z-growth synthetic and swept Z-growth synthetic quartz resonators as a function of time after exposure to a pulse (70 nanoseconds) of gamma radiation (Bremsstrahlung) from the Sandia Laboratories' Hermes II facility. Exposures were typically in the range of 10^4 to 10^5 Rad/pulse. The crystal units were driven by solid-state oscillators with different circuit configurations and physical layouts, and with sufficient gain margin to insure oscillation for a threefold increase in the equivalent series resistance, R_1 ($\propto Q^{-1}$), of the crystal unit. The oscillator frequency was monitored before, during, and following each exposure. In addition, one of the test oscillators permitted both the frequency and R_1 to be monitored simultaneously after exposing the crystal unit to pulse irradiation. Results are presented and discussed. (WHK)

12807 CRYSTAL CONTROLLED OSCILLATORS FOR RADIATION ENVIRONMENTS. Paradysz, R. E.; Smith, W. L. (Bell Telephone Labs., Allentown, PA). pp 120-123 of Proceedings of the Twenty-Seventh Annual Frequency Control Symposium. Washington, DC; Electronic Industries Association (1973).

From 27th annual frequency control symposium; Cherry Hill, New Jersey, USA (12 Jun 1973). See CONF-730622-.

Crystal controlled oscillators have usually been designed to obtain optimum frequency stability; however, in some applications reliability in adverse operating environments is more important than frequency stability. Some design trade-offs between frequency stability and operational reliability as applied to oscillators used in a transient radiation environment are discussed. Experimental results have confirmed that design margins have been realized, and observed performance of crystal-controlled oscillators during exposure to transient ionizing radiation has lead to new insight into the short-term effects of radiation on quartz crystals. (auth)

12808 TRANSIENT X-RAY INDUCED CONDUCTIVITY IN SINGLE CRYSTAL AND FUSED QUARTZ. Hughes, R. C. (Sandia Labs., Albuquerque, NM). pp 128-135 of Proceedings of the Twenty-Seventh Annual Frequency Control Symposium. Washinton, DC; Electronic Industries Association (1973).

From 27th annual frequency control symposium; Cherry Hill, New Jersey, USA (12 Jun 1973). See CONF-730622-.

The charge carrier transport properties of a wide variety of single crystal and fused quartz have been measured by creating electron-hole pairs in the bulk of the samples with high energy x-rays. The very short x-ray pulse (3 nsec) allows unprecedented time resolution, and in some cases separate measurements of carrier concentration, α, lifetime, τ, and mobility, μ, as well as their product ($\alpha e \mu \tau$). The $\alpha e \mu \tau$ product, where e is the electronic charge, is sometimes called the radiation induced conductivity (RIC) and was found to vary over almost four orders of magnitude for different types of quartz. In addition, substantial long term conductivity was discovered in some kinds of single crystal quartz cut with the electric field parallel with the c-axis. The possible origin of these long-lived charge carriers is discussed as well as their role in the short term annealing of the radiation-induced frequency offsets noted in quartz oscillators. (auth)

12809 EFFECTS OF ^{60}Co GAMMA RAY IRRADIATION ON THE OPTICAL PROPERTIES OF NATURAL AND SYNTHETIC QUARTZ FROM 85 TO 300°K. Mattern, P. L. (Univ. of California, Livermore); Lengweiler, K.; Levy, P. W. pp 139-152 of Proceedings of the Twenty-Seventh Annual Frequency Control Symposium. Washington, DC; Electronic Industries Association (1973).

From 27th annual frequency control symposium; Cherry Hill, New Jersey, USA (12 Jun 1973). See CONF-730622-.

The resonant frequency and stored energy (Q) values of quartz oscillators are altered by exposure to x-rays or gamma-rays. These changes have been attributed to alterations in the anelastic absorption spectrum. In turn, observed changes in the acoustic absorption properties of resonators have been related to radiation induced point defects and the modification, by radiation, of existing defects. To obtain additional information on the mechanisms by which point defect and trapped charge concentrations affect quartz resonators, optical absorption and luminescence measurements were made on both natural and synthetic quartz, during and after ^{60}Co irradiation. The results are discussed in the context of previously reported anelastic absorption measurements. All of the absorption and luminescence measurements described indicate that extensive trapped charge redistribution occurs in quartz both during and after irradiation, and may be stimulated by increasing the temperature of irradiated samples. These processes are discussed in terms of the current models of radiation induced defects in quartz. Also considered are interactions between these processes and the properties of unirradiated and irradiated quartz resonators. (WHK)

Miscellaneous Instruments

12810 (AEEW-R-919) INTERFERENCE IMMUNITY TESTS FOR NUCLEONIC INSTRUMENTATION. Fowler, E. P. (UKAEA Reactor Group, Winfrith, Atomic Energy Establishment). Apr 1974. 27p. Dep. NTIS (US Sales Only) $4.50. UK 50 pence.

Test procedures are described which, if applied to individual electronic instruments and to complete measuring systems or channels, will demonstrate if an adequate degree of immunity to electrical interference has been achieved. Their adoption for design approval of nucleonic instruments and for commissioning purposes on nucleonic instrumentation systems is strongly recommended. (auth)

12811 (EUR-5112) DIGITAL SYSTEM FOR SPEED AND PHASE CONTROL OF PHASED NEUTRON CHOPPER ARRAYS. Bettendroffer, E.; Eder, J. (Commission of the European Communities, Ispra (Italy). Joint Nuclear Research Center). 1974. 28p. Dep. NTIS (US Sales Only) $4.50. EUR B.FR. 40.-.

Phased chopper arrays for slow neutron experiments require electrical drive systems with high stability in speed and phasing of the different rotors. A modular drive system which uses digital speed and phase control has been developed. This report gives the design of the control modules for speed and phase settings. All timing signals are derived from a central crystal clock which guarantees the required high long term stability of speeds and phases. The settings may be adjusted manually or automatically by a computer through an appropriate interface. (auth)

12812 (IAE-2191) PROGRAMMING DEVICE WITH A LIGHT PENCIL FOR TIME-AMPLITUDE MEASUREMENTS WITH AI-4096-3M ANALYZER. Krupin, S. V.; Sotnikov, S. K.; Volchkov, V. A.; Tsitovich, A. P. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1972. 7p. (In Russian). INIS.

By means of this device it is possible to program the presentation of amplitude measurements in eight regions of the time spectrum obtained on an AI-4096-3M analyzer. In the "teach" mode of the analyzer the time spectrum is brought out onto an electron-beam tube, and the regions of interest to the experimenter are outlined by a light pencil. The signal obtained from the pencil forms a code corresponding to the time addresses of the regions to be programmed, which is written in three of the earlier planes of the ferrite cube of the analyzer. An analysis of a time-amplitude is presented in correspondence with this code. Amplitude spectra along 512 channels each are measured in eight regions programmed with respect to time of flight. The dead time during registration of pulses in the programmed region was: 60 microsec + 0.5n (n is the number of the amplitude channel). (SJR)

12813 (IFTJ-45) ANALOG FUNCTION MODULES. Korbel, K.; Lacki, E. (Institute of Nuclear Physics and Techniques, Krakow (Poland)). 1973. 36p. Dep. NTIS (US Sales Only) $5.00.

Descriptions and technical data of a set of nonlinear operational devices with continuous characteristics, performing the multiplication, division and extraction of a root of analog input signals are presented. These devices are of the logarithmic type. The logarithmic and alogarithmic dependences are obtained directly in a set of transistor semiconductor junctions. The requirements imposed on the logarithmic and alogarithmic operational devices are given, the analysis of linearity and temperature stability as well as the description of the basic circuit structures are presented. (auth)

12814 (INIS-mf-1245) APPARATUS FOR THE STUDY OF IONIC EMISSION FROM CLEAN METAL SURFACES UPON ION BOMBARDMENT. Suurmeijer, E.P.T.M. (Rijksuniversiteit Groningen (Netherlands)). 6 July 1973. 143p. INIS.

Experiments have been set up to investigate the energy distributions of the different types of ions leaving atomically-clean and well-defined monocrystalline metal targets upon bombardment with noble gas ions in the energy range below 10 keV. A review is given of the presently-available adequate information in the field of ion reflection from metal surfaces. The set-up consists of a Nier-type ion source, a 60° magnetic analyzer, a collision chamber and an 85° cylindrical energy analyzer followed by a sensitive detector. The target is mounted in the center of the collision chamber and can rotate through an axis lying in its surface plane. Large scintillator crystals should be used which may be considered to be disadvantageous with regard to detection sensitivity and system geometry. Both problems are solved by making the converter adjustable and coupling its position with the initial ion energy. This solution is discussed on the basis of numerical ion and electron trajectory calculations performed on a simplified model. With the results of these calculations a detector has been developed with an adjustable converter such that the requirements can be fulfilled and the eventual influence of inhomogeneity effects on the detector efficiency is precluded. Application of the detector during investigations on the multiple reflection of noble gas ions on copper and sodium chloride crystals has appeared to be successful. (INIS)

12815 (JINR-10-6956) PROGRAM FOR THE MARKING OF MEASUREMENT RESULTS OF CAMERA PHOTOGRAPHS BY MEANS OF SEMIAUTOMATIC MEASURING DEVICES. Ruzdavina, N. A.; Ivanov, V. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation). 1973. 17p. (In Russian). INIS.

A program designed for the marking and control of the results of the measurement of camera photographs on the semiautomatic device of the Joint Institute for Nuclear Research and for recording these results on a magnetic tape in a format required by the THRESH geometric reconstruction program is examined. (tr-auth)

12816 (JINR-10-7075) UNITS AND ELEMENTS OF AUTOMATIC SYSTEM OF STORAGE AND DATA PROCESSING. Kustov, A. P.; Medved, S. V.; Pan'ko, I. A.; Chistov, N. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1973. 19p. (In Russian). INIS.

The basic elements and units of a system for the storage and processing of data at the Laboratory of Nuclear Problems are described. Block diagrams of the display selection units and the automatic transfer units are given. The principal circuits of the console, input grid inverter, and control units with arithmetic recording are shown. (tr-auth)

12817 (JINR-13-7085) WIDELY ADOPTED AMPLITUDE-PULSE CONVERTER. Antyukhov, V. A.; Semenov, B. Yu. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1973. 21p. (In Russian). INIS.

A converter is described which was developed to adapt the equipment to a wide circle of physical experimental problems with the use of the most simple means. The device accepts pulses of positive polarity having an amplitude up to 10 V. The frequency of the exit pulse train is 25 or 2 MHz; the maximum number of pulses in a set (number of channels) is 256. The control (logic) part of the unit consists of integral microcircuits with the principal block (the charging unit) consisting of the latest circuitry with differential cascade on field transistors at the inlet and with a current repeater at the exit. A linear transmission circuit is installed at the converter inlet. The instrument was made at the Laboratory of Nuclear Problems. (SJR)

12818 (SLL-74-5) APPLICATION SOFTWARE FOR ELECTRON MICROPROBE ANALYSIS AND DATA REDUCTION. Benthusen, D. E.; Estill, W. B. (Sandia Labs., Livermore, Calif. (USA)). Jun 1974. Contract AT(29-1)-789. 36p. Dep. NTIS $4.00.

Applications software developed to control an automated electron microprobe during data acquisition and to reduce the raw data into percentages of each elemental constituent is described. A high-level interpretive computer language called CLASS was used to write the software and a special adaptation of MAGIC IV was used to make the X-ray intensity corrections. (auth)

12819 CODED APERTURE IMAGING USING ON-AXIS FRESNEL ZONE PLATES AND EXTENDED GAMMA-RAY SOURCES. Tipton, M. D.; Dowdey, J. E.; Bonte, F. J.; Caulfield, H. J. (Univ. of Texas, Dallas). Radiology; 112: No. 1, 155-158(Jul 1974).

A two-step autoradiographic imaging technique utilizing a coded aperture in the form of a lead on-axis Fresnel zone plate is presented. Several isotope-filled plastic phantoms were successfully imaged. These images contain tomographic information of very good quality. The advantages and disadvantages of the technique are discussed. (auth)

12820 RETARDATION SYSTEM AND COLLISION CHAMBER OF THE TANDEM MASS SPECTROMETER. Ardelean, P.; Mercea, V.; Ioanoviciu, D.; Cuna, C. (Inst. of Stable Isotopes, Cluj). Rev. Roum. Phys.; 19: No. 1, 49-54(1974).

A retardation system and a collision chamber of the tandem mass spectrometer are described. The performance of the apparatus was tested using N_2^+ and H_2^+ as primary ions. (auth)

12821 ANALYSIS OF FIELD ION ENERGIES IN A MASS SPECTROMETER. Goldenfeld, I. V.; Korostyshevsky, I. Z.; Mischanchuk, B. G. (AN Ukrainskoj SSR, Kiev. Inst. Fizicheskoj Khimii). Int. J. Mass Spectrom. Ion Phys.; 13: No. 4, 297-311 (Apr 1974).

The energy distribution of various ions formed by field ionization on a tip has been investigated by a retarding potential technique. The field appearance potentials (AP_f) for singly- and doubly-charged molecular ions and ion clusters are shown to be equal to the energies of their formation. This has made it possible to measure the ionization potentials of a number of molecules and radicals, to determine the bond energy in the $H_3O^+ - H_2O$ ion (1.60 ± 0.1 eV), the proton affinity of the formic acid molecule (8.10 ± 0.1 eV) and the hydrogen atom affinity of the NH_4^+ ion (>4 eV). It is also shown that the energy distributions of different fragment ions are greatly dependent upon the types of bonds broken and structures of fragments. (auth)

12822 THE TRUNCATED HILL DETERMINANT AS A TOOL IN QUADRUPOLE MASS FILTER STUDIES. Richards, J. A. (James Cook Univ. of North Queensland, Townsville (Australia)); Huey, R. M. (Technische Hochschule Aachen (F.R. Germany)); Hiller, J. (New South Wales Univ., Kensington (Australia). School of Electrical Engineering). Int. J. Mass Spectrom. Ion Phys.; 13: No. 4, 443-451(Apr 1974).

It is shown that the classical technique of Hill determinant analysis can be readily applied to quadrupole mass filter studies owing to the ability to consider finite truncated approximations to the usual infinite Hill determinant. Using this approach the harmonic composition of the voltage waveform applied to the electrodes of a quadrupole mass filter is analyzed with a view to assessing its affect on device performance. It is shown that harmonics of the order of the fifth and higher have little influence on the stability of the ionic trajectories, thereby allowing these harmonics to be disregarded when contemplating the practical features of the mass filter's electronic circuitry. (auth)

12823 HADAMARD TRANSFORM PHOTOELECTRON SPECTROMETER. Allen, J. D. Jr.; Schweitzer, G. K. (Univ. of Tennessee, Knoxville). J. Electron Spectros. Relat. Phenomena; 1: No. 5, 509-510(May 1973).

A preliminary report on the design, construction, and testing of a Hadamard transform photoelectron spectrometer is presented. Such an instrument has the advantage of simultaneous observation of many spectral elements without the need for more than one detector. Full details of the instrument and its operation will appear in an extensive paper to be published shortly. (auth)

12824 HIGH-TEMPERATURE PHOTOELECTRON SPECTROMETER. Allen, J. D. Jr.; Boggess, G. W.; Goodman, T. D.; Wachtel, A. S. Jr. (Univ. of Tennessee, Knoxville). J. Electron Spectros. Relat. Phenomena; 2: No. 3, 289-294(Oct 1973).

A description is given of a newly-developed photoelectron spectrometer designed specifically for the observation of the vapors of compounds which are volatilized to give pressures around 10^{-2} torr in the interaction region at temperatures up to about 1000°C. A unique feature of the instrument is its internally-located vaporization oven, the heating power for which is imported by a laser beam. Experimental data have been obtained which indicate that the apparatus functions as it was designed. (auth)

12825 HIGH RESOLUTION ESCA INSTRUMENT WITH X-RAY MONOCHROMATOR FOR GASES AND SOLIDS. Gelius, U.; Basilier, E.; Svensson, S.; Bergmark, T.; Siegbann, K. (Uppsala Univ.). J. Electron Spectros. Relat. Phenomena; 2: No. 5, 405-434(Dec 1973).

A new ESCA instrument with a fine-focussing x-ray monochromator, a high power electron gun, a rotating anode and a computerized multi-detector system is described. The instrument is suitable for the study of both solids and gases. The improved performance of the instrument is illustrated by a

number of new spectra. Thus, spectra of gold, neon, methane, air, trifluoroacetate, thiophene and carbonyl sulphide, carbon monoxide, nitrogen, benzene and trithiapentalene are reported. (auth)

12826 SOME SOLID STATE PHOTODETECTORS USED IN PULSE RADIOLYSIS STUDIES. Operational Details and Performance. Baxendale, J. H.; Bell, C.; Mayer, J. (Univ. of Manchester, Eng.). Int. J. Radiat. Phys. Chem.; 6: No. 2, 117-128(Apr 1974).

A germanium photodiode, type L-4521 (Philco-Ford), and a silicon photodiode, type HP-4220 (Hewlett-Packard), have been examined with respect to their behaviour to light absorption signals as obtained in pulse radiolysis, and compared with a photomultiplier. The factors considered were the accuracy of measurement of the amplitude and decay characteristics of a signal over a range of wavelengths and the response times. Both diodes are found to have rapid rise times (several nanoseconds) for practical purposes. Wavelength and time ranges are given over which reasonably accurate reproduction of absorption signals can be expected. A cursory examination of the indium arsenide diode A-100 (Barnes Engineering Co.) is also given. (auth)

12827 PULSED-ION SPECTROMETER. Mironov, S. G. (Inst. of Theoretical and Applied Mechanics, Novosibirsk, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 16: No. 6, 1636-1638(1973).

Translated from Prib. Tekh. Eksp.; 16: No. 6, 24-26(1973).

An electrostatic pulsed-ion-beam spectrometer is described which allows measurement of the energy spectrum of the ions during one pulse. The spectrometer uses buffer memory of the ion spectrum on the dielectric plate. Readout is accomplished by the electron beam in the interval between pulses. The results of tests of the instrument are presented, and the causes influencing the accuracy of the measurements are indicated. (auth)

12828 ENERGY ANALYZER FOR A BEAM OF CHARGED AND NEUTRAL PARTICLES. Ol'dekop, L. G.; Evlanov, E. N.; Zubkov, B. V.; Lebedev, Yu. V.; Leonas, V. B. (Inst. of Space Research, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 16: No. 6, 1639-1641(1973).

Translated from Prib. Tekh. Eksp.; 16: No. 6, 27-29(1973).

The principles of operation, construction, and characteristics of an energy analyzer for beams of neutral and charged particles having energies of 2 to 14 eV are described. The instrument is designed for operation on board artificial earth satellites. (auth)

12829 ENERGY DISPERSION X-RAY ANALYSIS WITH ELECTRON AND ISOTOPE EXCITATION. Sandborg, A. O. (Nuclear Diodes, Inc., Prairie View, IL). pp 113-124 of Energy Dispersion X-ray Analysis: X-ray and Electron Probe Analysis. Russ, J. C. Philadelphia; American Society for Testing and Materials (1971).

From symposium on energy dispersion x-ray analysis: x-ray and electron probe analysis; Toronto, Ont, Canada (21 Jun 1970). See ASTM-STP-485; CONF-700683-.

The components of the energy dispersion x-ray analysis system are discussed, and the electronic noise of peak broadening due to each is identified. Data on count rates and sensitivity are listed for various elements to enable the prospective user to determine whether the technique is applicable to his specimens. Specific comparison is made between the use of electron beams, radioactive isotopes, and x-ray tubes to excite the characteristic x-ray lines of interest. The ability to distinguish small peaks when bremsstrahlung (white radiation) is present due to the use of direct electron excitation, or when scattering of incident x-rays or gamma rays occurs is discussed. (auth)

12830 LIGHT ELEMENT ANALYSIS USING THE SEMICONDUCTOR X-RAY ENERGY SPECTROMETER WITH ELECTRON EXCITATION. Russ, J. C. (Jeolco, Inc., Medford, MA). pp 217-231 of Energy Dispersion X-ray Analysis: X-ray and Electron Probe Analysis. Russ, J. C. Philadelphia; American Society for Testing and Materials (1971).

From symposium on energy dispersion x-ray analysis: x-ray and electron probe analysis; Toronto, Ont, Canada (21 Jun 1970). See ASTM-STP-485; CONF-700683-.

Limitations on light element analysis include the low fluorescent yield of low atomic number elements and the interference of closely spaced K-lines and L- and M-lines of heavier elements. The paper discusses the relative contributions of electronic noise and statistical line width for low-energy x-rays and the effect of detector window thickness, along with the possibility of reducing or eliminating the window. Optimum accelerating voltages for light elements are calculated, and the importance of takeoff angle is stressed. Examples are given of the minimum detectable limits obtainable at the present state of the art; the possibilities for development in the near future are discussed. (auth)

12831 RAPID QUANTITATIVE ELECTRON PROBE MICROANALYSIS WITH A NONDIFFRACTIVE DETECTOR SYSTEM. Myklebust, R. L.; Heinrich, K. F. J. (National Bureau of Standards, Washington, DC). pp 232-242 of Energy Dispersion X-ray Analysis: X-ray and Electron Probe Analysis. Russ, J. C. Philadelphia; American Society for Testing and Materials (1971).

From symposium on energy dispersion x-ray analysis: x-ray and electron probe analysis; Toronto, Ont, Canada (21 Jun 1970). See ASTM-STP-485; CONF-700683-.

Nondiffractive detector systems on electron probe microanalyzers have decreased the time required for a qualitative analysis from 30 or 40 min to 1 or 2 min. The nondiffractive technique may be extended to the quantitative determination of an element by comparing either the peak height or the area beneath the peak of the signal from the specimen with that from the pure chemical element or a standard of known composition run under identical conditions. Results are given for quantitative analyses of several materials with a lithium-drifted silicon detector, used for x-ray lines above 1 keV, and a gas flow proportional detector, for x-ray lines from 0.16 to 1.5 keV. Quantitative analyses can be accomplished only when the experimental conditions are carefully selected and maintained throughout the measurement. They are then sufficiently precise to warrant the use of a "matrix" correction procedure to obtain concentrations. An analog curve analyzer is useful for resolving overlapping peaks and for integrating the areas beneath the peaks. (auth)

12832 DESIGN AND APPLICATION OF X-RAY EMISSION ANALYZERS USING RADIOISOTOPE X-RAY OR GAMMA RAY SOURCES. Rhodes, J. R. (National Bureau of Standards, Washington, DC). pp 243-285 of Energy Dispersion X-ray Analysis; X-ray and Electron Probe Analysis. Russ, J. C. Philadelphia; American Society for Testing and Materials (1971).

From symposium on energy dispersion x-ray analysis: x-ray and electron probe analysis; Toronto, Ont, Canada (21 Jun 1970). See ASTM-STP-485; CONF-700683-.

The present state of development and application of x-ray emission spectrometry using radioisotope x-ray and gamma ray sources for excitation, and energy discrimination and dispersion techniques for spectrum analysis is reviewed. The design and use of instrumentation is characterized by the choice of one of the two main methods of energy selection now employed. The balanced filter method is simple but restricted to sequential determinations of single elements and so finds its main use in small, hand-portable, battery-operated analyzers for field, laboratory, or industrial use. Energy dispersion with high resolution silicon or germanium detectors permits simultaneous collection of the whole excited spectrum and so promises rapid multielement analysis. Available equipment is more suited to laboratory conditions. Relevant components of radioisotope x-ray spectrometers are described. Emphasis is placed on source-specimen-detector configurations, sources, source-target assemblies, absorption edge filters, and relevant properties of detectors. Equations for estimating the feasibility of a given analysis are derived, and interferences due to absorption, enhancement, and heterogeneity effects are discussed. A major portion of the paper is devoted to a review of published applications and covers elemental analysis from aluminum to uranium, and measurement of coating thickness. References are made where appropriate to available portable, industrial, and laboratory instruments. (137 references) (auth)

12833 MEASUREMENT OF WIDE AND NARROW MASS DIFFERENCE ON THE MANITOBA II MASS SPECTROMETER. Southon, F. C. G. Winnipeg, Manitoba; Univ. of Manitoba (1973). National Library of Canada, Ottawa.

Thesis (Ph. D.).

The primary objective of this work has been the measurement of mass doublets having a greater spacing than those previously measured by this group, i.e., doublets for which ($\Delta M/M > 1/17{,}000$). Instrumental modifications are described, and the present experimental limitations for precise measurements are discussed. With the system developed, measurements were made to improve the knowledge of the $^{37}Cl-^{35}Cl$ mass difference, and to correlate the ends of a long chain of mass differences measured in this and previous work, viz. by linking lutetium and neodymium nuclides. Some narrow mass differences are reported, and a new type of computer-assisted matching system is discussed. Previous mass measurements carried out in this laboratory have been corrected for the systematic errors discovered in this work and a new adjustment carried out. Knowledge of systematic variations of the double neutron separation energy (S_{2n}) for $104 \leq N \leq 112$ has been extended and is discussed. (Diss. Abstr. Int., B)

ISOTOPE AND RADIATION SOURCE TECHNOLOGY

Isotope Separation (Industrial)

12834 (CTC-60) GENERAL TRANSIENT PRODUCTIVITY PROGRAM. Burris, J. H.; Tunstall, J. N. (Union Carbide Corp., Oak Ridge, Tenn. (USA). Computer Sciences Div.). 14 Jun 1974. Contract W-7405-eng-26. 77p. Dep. NTIS $5.45.

The General Transient Productivity Code, a computer program written in FORTRAN for the IBM 360/195 that solves for the transient enrichment of a multicomponent, multisectioned isotope separation cascade with multiple side streams is described. The mathematical model employed and the numerical technique the program uses are detailed. Complete user documentation for the code is given along with the program listing and the results of a test case. (auth)

Isotopic Power Sources

12835 (ARCO-3057-17) RADIOISOTOPE POWERED CARDIAC PACEMAKER PROGRAM. Quarterly Progress Report, February 1, 1973–April 30, 1974. (Arco Nuclear Co., Leechburg, Pa. (USA)). 1974. Contract AT(11-1)-3057. 48p. Dep. NTIS $5.45.

The Radioisotope Powered Cardiac Pacemaker program continued with 47 implants in humans resulting in 39.4 unit years of reliability data; 504.4 unit years of electronic circuits life testing; and 57.7 unit years of dog implantation data. Summaries of cremation and pressurized capsule tests are presented. Preliminary package shipment results and package response to temperature changes are discussed. (LCL)

12836 (COO-3043-10) EVALUATION OF PRACTICABILITY OF A RADIOISOTOPE THERMAL CONVERTER FOR AN ARTIFICIAL HEART DEVICE. Phase II. Final Report. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 15 Sep 1973. Contract AT(11-1)-3043. 224p. Dep. NTIS $7.60.

The results of Phase II of a continuing program toward the development of a total artificial heart system in which thermal energy is supplied by the decay of ^{238}Pu are presented. In Phase I, many possible systems were evaluated and a Stirling-mechanical system concept was selected for further development and evaluation. The objective of Phase II was the assessment of the practicability of developing a fully implantable version of that system. Practicability criteria are formulated within five major categories, i.e., isotope inventory and environmental aspects; implantation factors; performance; lifetime and reliability; and costs. The parametric, design and experimental studies toward refinements of components and systems designs and the confirmation of design principles of the successful operation of a bench model system are described. The operating experience, test data and design studies are used as bases for identification of further development toward satisfaction of the practicability criteria and for estimation of the characteristics of a fully developed nuclear-powered artificial heart. It is concluded that a system comprised of a Stirling cycle thermal energy converter directly coupled to a mechanical blood pump drive can be developed to meet the practicability criteria for each of the five categories established. (auth)

12837 (MLM-2001) ARTIFICIAL HEART HEAT SOURCE PROGRAM: A SUMMARY REPORT. Prosser, D. L.; Brewer, C. O.; Coffey, D. L.; Johnson, E. W. (Mound Lab., Miamisburg, Ohio (USA)). 15 Jun 1973. Contract AT(33-1)-Gen-53. 114p. Dep. NTIS $5.45.

Three artificial heart heat sources were assembled using components designed and fabricated by TRW Systems. Each triply encapsulated source contained 33 W(th) of plutonium dioxide with 90% ^{238}Pu. The fuel was prepared at Los Alamos Scientific Laboratory by reacting electrorefined plutonium metal with ^{16}O and then pelletizing. The source consisted of a platinum-20% rhodium linear and clad member and a T-111 strength member. The design included a pressure relief device (PRD) to dissipate the helium released by the decay of the plutonium. Weld parameters were developed and 12 test capsules loaded with fuel simulant were shipped to TRW Systems. Two of the fueled units were shipped to the Westinghouse Astronuclear Laboratory to be used in the Sterling mechanical converter. One was covered with an emissive coating. The third unit was sent to Los Alamos Scientific Laboratory for long term testing. Before shipment all fueled units were subjected to detailed inspection to ensure their integrity. Their radiation characteristics were also established. (auth)

Radiation Sources

Refer also to abstract 13051.

12838 TRITIUM ION BEAM FOR AN INTENSE NEUTRON SOURCE, INS. Emigh, C. R. (Los Alamos Scientific Lab., NM). pp 272-276 of Proceedings of the Fifth Symposium on Engineering Problems of Fusion Research. New York; Inst. of Electrical and Electronics Engineers, Inc. (1974).

From fifth symposium on engineering problems of fusion research; Princeton, New Jersey, USA (6 Nov 1973). See CONF-731114-.

The INS facility was proposed to provide a neutronic environment similar to that anticipated in a fully operational fusion-power reactor. An annular duoplasmatron is described which is designed to provide long-life reliability (> 2000 hrs), a high gas efficiency (> 20%), and high-quality beam generation (normalized emittance ~ 0.3 cm-mrad). (MOW)

Design and Fabrication

12839 IMPROVEMENTS IN DESIGN OF A ^{90}Sr–^{90}Y PORTABLE BLOOD IRRADIATOR. Hungate, F. P.; Griffin, B. I.; Cross, F. T.; Riemath, W. F. (Battelle-Pacific Northwest Labs., Richland, WA). pp 380 of Proceedings of the 26th Annual Conference on Engineering in Medicine and Biology. Vol. 15. Arlington, VA; Alliance for Engineering in Medicine and Biology (1973).

From 26th conference on engineering in medicine and biology; Minneapolis, Minnesota, USA (30 Sep 1973). See CONF-730974-.

A ^{90}Sr–^{90}Y portable blood irradiator for extracorporeal irradiation of blood was designed and constructed. Preliminary data indicated that surface dose rates are slightly in excess of the design dose rate of 50 mrem/h. Proposed improvements in shielding design should improve this. (ERB)

Industrial Uses

Refer also to abstracts 12334, 12357, and 12358.

12840 PROBLEMS IN FORMULATING UNSATURATED POLYESTER-BASED COATINGS THAT CAN BE HARDENED BY ELECTRON BEAMS. Godineau, P. (Charbonnage de France-Chimie, Courbevoie, France). Rev. Gen. Caout. Plast.; 50: No. 11, 894-895(Nov 1973). (In French).

From meeting on the development of the industrial applications of radiochemistry; Paris, France (13 Mar 1973).

The crosslinking of polyester resins, coatings and varnishes by irradiation has numerous advantages over other techniques. The specific parameters of the polyesters and resins used are examined in detail (level and nature of monomer; degree of undersaturation of polyesters; degree of condensation; level and nature of the inhibitors; level of crosslinking). (FR)

12841 MEASUREMENTS IN ROTATING DRUMS WITH THE AID OF RADIOACTIVE TRACERS. Van Dalen, A. (Stichting Reactor Centrum Nederland, Petten). Polytech. Tijdschr., Procestech.; 29: No. 1, 9-13(9 Jan 1974). (In Dutch).

The tracers used are ^{24}Na, ^{42}K, and ^{82}Br. These are used to obtain the graph of concentration against time for materials flowing through a rotating drum used as a centrifuge. By means of a theoretical analysis based on classical diffusion theory these diagrams can be interpreted and optimum flow conditions obtained. (NL)

12842 POSSIBILITY OF DRYING PAINTS AND VARNISHES ON PARTICLE BOARD PANELS BY ELECTRON BOMBARDMENT. Dillemann, H. (Societe TAM-SAMES, Grenoble, France); Grosmaire, P. Rev. Gen. Caout. Plast.; 50: No. 11, 907-908(Nov 1973). (In French).

From meeting on the development of the industrial applications of radiochemistry; Paris, France (13 Mar 1973).

Experience acquired in the drying of paints and varnishes by electron bombardment is presented. The practical application of this method is examined together with the advantages of irradiation techniques, i.e., reduction in atmospheric pollution, fire hazards, and improvement in working conditions. (FR)

12843 RADIOHARDENABLE POLYEPOXIDE RESINS. Application to Ionizing Radiation Sticking. Bex, G.; Acquacalda, J. M. (Centre d'Etudes Scientifiques et Techniques d'Aquitaine, Le Barp, France). Rev. Gen. Caout. Plast.; 50: No. 11, 890-892(Nov 1973). (In French).

From meeting on the development of the industrial applications of radiochemistry; Paris, France (13 Mar 1973).

Radiohardenable resins can be made by modifying commercial epoxide resins with acrylic acid, or by synthesis from glycidyl acrylate and diphenols. A brief description is given of the preparation of these products together with the purification of the synthesis derivatives. Acid modified resins were observed to harden very rapidly when exposed to ionizing radiation. The synthesis derivatives, on the other hand, crosslink more slowly as a consequence of their high viscosities. The effect of irradiation dose on the sticking of copper test pieces using different resins is presented. (FR)

12844 PRODUCTION OF RADIOVULCANIZED NATURAL LATEX. Laizier, J. (CEN de Saclay, Gif-sur-Yvette, France). Rev. Gen. Caout. Plast.; 50: No. 11, 897-899(Nov 1973). (In French).

From meeting on the development of the industrial applications of radiochemistry; Paris, France (13 Mar 1973).

The prevulcanization of rubber latex can be carried out by irradiation with electron beams of γ rays. The product "Precurtex" is obtained relatively inexpensively and is easy to work with. It is stable with respect to time and possesses a remarkable purity. The mechanisms involved in the cross-linking are as yet unknown. (FR)

LIFE SCIENCES

12845 (ANL-8070) DIVISION OF BIOLOGICAL AND MEDICAL RESEARCH ANNUAL REPORT, 1973. (Argonne National Lab., Ill. (USA)). Dec 1973. Contract W-31-109-eng-38. 246p. Dep. NTIS $7.60.

Separate abstracts were prepared for eight sections of this report. A list is included of 82 publications appearing during the year covered by this report. (CH)

For abstracts of individual sections see: 12862, 12882, 12883, 12961–12963, 13007, and 13013.

Radiation Effects on Biochemicals

Refer also to abstracts 12334, 12943, and 13002.

12846 (AEC-tr-7548, pp 7-13) FORMATION OF FREE RADICALS IN DNA UNDER THE SIMULTANEOUS ACTION OF IONIZING RADIATION AND LIGHT. Skvortsov, V. G.; Zhdanov, G. S.; Milinchuk, V. K.; Pshezhetskii, S. Ya. (Physicochemical Scientific Research Inst., Obninsk, (USSR). 1974. Translated from Radiobiologiya; 13: No. 1, 8-12(1974).

The formation of paramagnetic centers (PC) in thymus DNA under the simultaneous, successive, and periodic action of γ radiation and light at 77 and 300°K was studied by the ESR method. In the case of simultaneous influence at 77°K, the yield of PC is 2 to 2.8 times as great as in the case of successive influence. Regardless of the method of irradiation, radicals are formed on thymine in equal amounts. The PC in DNA in the case of joint and periodic action are of a different nature than in the case of γ irradiation. They are stable to the action of light but possess lower thermal stability in comparison with the radicals formed after γ irradiation. Possible mechanisms of the formation of free radicals in DNA in the case of simultaneous and periodic irradiation are discussed. (tr-auth)

12847 (AEC-tr-7548, pp 14-23) DEGRADATION, SYNTHESIS, AND REPAIR OF DNA IN CELLS OF E. COLI UVR 502 AFTER UV IRRADIATION. Synzynys, B. I.; Il'ina, T. P.; Smirnov, G. B.; Saenko, A. S. (Scientific Research Inst. of Medical Radiology, Obninsk, USSR). 1974. Translated from Radiobiologiya; 14: No. 1, 13-20(1974).

The degradation, synthesis, and repair of DNA in cells of E. coli UVR 502 after uv irradiation were studied. It was established that the strains UVR^+ and UVR 502 are characterized by a low level of degradation of DNA after the action of uv light at a dose of up to 150 erg/mm^2. UV irradiation at a dose of 100 erg/mm^2 leads to a delay in DNA synthesis; the time of the delay of DNA synthesis in the mutant UVR 502 is about 30 min, and in UVR^+ cells about 15 min. The cells of the mutant UVR 502 possess a defect in the prereplicative system of repair. This defect is not associated with damage to the first stage of prereplicative repair–incision, but is evidently due to a disruption of the following stage of "excision–replacement." The UVR 502 mutation does not lead to any disruption of the system of postreplicative repair. (tr-auth)

12848 (EUR-5122(Vol.1), pp 235-258) RELATIVE BIOLOGICAL EFFECTIVENESS AND BIOLOGICAL COMPLEXITY. Barendsen, G. W. (Radiobiological Inst., TNO, Rijswijk, Netherlands). Mar 1974.

From fourth symposium on microdosimetry; Verbania, Italy (24 Sep 1973).

Various types of damage induced in double-stranded DNA by ionizing radiations which may contribute to impairment of the capacity for proliferation of phages, bacteria, and mammalian cells, are discussed. The relative contributions of single strand lesions, double strand lesions, nucleotide damage, and more complex changes depend on the radiation quality and on the complexity of the biological systems investigated. Relationships between the LET dependence of various contributions and the relative biological effectiveness of radiations for reproductive death are evaluated and their implications for various hypotheses and theories of radiobiological mechanisms are considered. With increasing complexity of the biological system, in general, the capacity for repair or restitution of primary damage appears to increase. Any hypothesis is proposed assuming that the dependence of RBE on LET for impairment of the reproductive capacity of mammalian cells results from the fact that this effect is caused by interaction of at least two complex lesions, each produced in the nucleohistone fibres of 70 to 100 Å diameter which are considered to constitute the basic structural components of chromatin in eukaryotic cells. (auth)

12849 (EUR-5122(Vol.1), pp 353-366) TWO-IONIZATION VERSION OF LEA'S TARGET THEORY. Holt, P. D. (Atomic Energy Research Establishment, Harwell, Eng.). Mar 1974.

From fourth symposium on microdosimetry; Verbania, Italy (24 Sep 1973).

Lea's target theory gives a method by which the number of targets of a particular radius, per unit mass of irradiated material, that have received one or more primary energy loss events may be calculated. A similar formulation is described here, that gives the number of targets which have received two or more energy loss events. Allowance is made for the production of a second energy loss event by the δ-ray produced in the first event. A discussion is presented of the application of this theory to the interpretation of published data on the production of double strand breaks in DNA in vitro, and on the inactivation of viruses containing double stranded DNA. (auth)

12850 (EUR-5122(Vol.1), pp 477-487) INACTIVATION CROSS-SECTIONS FOR RIBONUCLEASE IRRADIATED BY H, He, AND N BEAMS AT ENERGIES LESS THAN 10 keV. Sutcliffe, J. F.; Watt, D. E. (Univ. of Dundee, Scotland). Mar 1974.

From fourth symposium on microdosimetry; Verbania, Italy (24 Sep 1973).

Preliminary measurements were made of inactivation cross-sections for mono-energetic hydrogen, helium, and nitrogen beams variable between 200 eV and 10 keV. Each of the cross-section curves pass through a minimum value clearly indicating a division between inactivation due to quasielastic scattering and that due to inelastic electronic processes. Helium is less efficient at causing quasi-elastic inactivation than hydrogen at the same velocity while nitrogen is slightly more efficient. This leads to the unambiguous conclusion that the concentration of "knock-on" events along the incident particle track is a better description of radiation quality than the linear number of events, the linear mass-stopping power, or the energy deposited in unit volume defined by the mean range of the "knock-on" particles. The inelastic electronic inactivation cross-section shows no significant accidental resonant charge transfer. It is difficult to separate the contributions due to non-resonant charge transfer and simple ionization although the ratio of the observed electronic inactivation cross-section for N : He : H at the same velocities suggests that charge transfer processes may be at least comparable in magnitude with simple ionization at causing inactivation. Inactivation penetration depths (ranges) are measured to be about 30 times larger than reported theoretical and experimental ranges. The explanation for the theoretical discrepancy is sought in terms of channelling and, to a lesser extent, diffusion in the crystalline enzyme while previous experimental data may be in error due to failure to assess the true thickness of the crystalline layers. (auth)

12851 (KFK-1721) IN VITRO REPAIR OF SINGLE-STRAND BREAKS IN γ-IRRADIATED DNA BY POLYNUCLEOTIDE LIGASE. Jacobs, A.; Bopp, A.; Hagen, U. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Strahlenbiologie). Nov 1972. 5p. INIS.

The ability of polynucleotide ligase to eliminate single-strand breaks in γ-irradiated DNA was studied. The irradiated DNA was first labelled at the 5'-end of the break with ^{32}P-phosphate and treated in vitro with polynucleotide ligase. In phosphoester bonds joined by the ligase, the incorporated ^{32}P-phosphate is resistant to subsequent phosphate treatment. The number of sealed breaks, detected in this way, was compared with the total number of single-strand breaks measured in the analytical ultracentrifuge. In DNA with 0.4 to 2.0 radiation-induced single-strand breaks per 1,000 nucleotides, up to 40% of the breaks can be joined directly by the ligase. (auth)

12852 (SU-326-P-7-26) REPAIR OF DAMAGED DNA IN VIVO. Annual Progress Report, June 1, 1973–May 1, 1974. Hanawalt, P. C. (Stanford Univ., Calif. (USA). Dept. of Biological Sciences). May 1974. Contract AT(04-3)-326. 6p. Dep. NTIS $4.00.

Progress is reported on studies of molecular mechanisms and enzyme systems involved in the repair of DNA in Escherichia coli and HeLa cells following injury by uv irradiation. Differences in repair of DNA strand breaks in mutants of Escherichia coli are discussed. (CH)

12853 (SU-326-P-7-27) REPAIR OF DAMAGED DNA IN VIVO. Hanawalt, P. C. (Stanford Univ., Calif. (USA). Dept. of Biological Sciences). May 1974. Contract AT(04-3)-326-7. 23p. Dep. NTIS $4.25.

Progress is reported in studies of molecular mechanisms for the repair of DNA strand breaks in uv irradiated bacteria and HeLa cells. A list is included of 110 publications during the period covered by this report that present results of studies in detail. (CH)

12854 EFFECT OF γ RADIATION ON VITAMIN E FACTORS IN SOLUTION. I. Tributyrin Solution of α-Tocopheryl Acetate as well as α-, β-, and δ-Tocopherol. Bancher, E.; Washuettl, J.; Schiffauer, R. (Technische Hochschule, Vienna). Int. J. Vitam. Nutr. Res.; 43: 510-516(Apr 1973). (In German).

After γ irradiation of α-Tocopherol, α-Tocopherolacetate, β-Tocopherol, γ-Tocopherol, and δ-Tocopherol soluted in Tributyrin the only products of radiolysis obtained by a high radiation dose were the corresponding chinons of tocopherols. They could be identified and quantitatively determined. Whereas the damage of the four free tocopherols was between 40 to 70%, by the same dose no destruction was observed for α-Tocopherolacetate. The four free tocopherols were destroyed completely by a radiation dose of 50 Mrad, whereas the damage of α-Tocopherolacetate was only 56%. (auth)

12855 EFFECTS OF NEAR UV LIGHT PHOTOPRODUCTS OF EPINEPHRINE ON AQUEOUS HUMOR PROTEINS. Zigman, S. (Univ. of Rochester, NY). Invest. Ophthalmol.; 13: No. 2, 127-134(Feb 1974).

At a level of 0.01 per cent in isolated, pooled calf aqueous humor, epinephrine bitarirate is converted into a series of pigmented photoproducts by exposure to near uv light for only a few hours. The brown photoproducts, but not adrenochrome, bind to and alter the electrophoretic mobility of aqueous-humor proteins. The rapidity and mild conditions required for the above-described effects to occur, and other considerations of possible near uv photoproduct cellular toxicity, emphasize a need for physical or chemical measures to prevent near uv light exposure of the aqueous humor in patients treated with epinephrine, especially in the aphakic eye. (auth)

12856 RADIATION EFFECT ON SERUM FREE AMINO ACIDS. Serum Free Amino Acids as Biochemical Indicator for Radiation Injury. Toda, H. (Iwate Medical Coll., Morioka, Japan). Iwate Igaku Zasshi; 25: No. 4, 516-535(Aug 1973). (In Japanese).

For the experiments, adult male rats were used. Firstly, they were given a single dose of whole-body x-ray irradiation of 250 R, 500 R, and 1000 R. Secondly, a single dose of 500 R on the whole body, the liver only, and the whole body with shielded liver was given. In the case of whole body x-ray irradiation of 250 R, the increment of lysine, glycine, alanine, valine, serine, and glutamic acid was observed. Gradual increment of x-ray irradiation dose from 500 R to 1000 R brought the increment of the number of amino acids and raised the increment of the amount of amino acids. In all cases, increment of amount of amino acids was brought about just after irradiation and the increment reached the peak after irradiation, and the increment reached the peak after 24 hours or 3 days. In case of x-ray irradiation of 1000 R, the prominent increment was brought about furthermore, after 28 days showing an increasing pattern with two phases. The increment of amino acids was most intense in the case of whole-body x-ray irradiation and less intense in the case of liver irradiation and slightest in the case of whole-body irradiation with shielded liver. In both whole-body irradiation and liver irradiation, the numbers of increasing amino acids were rather almost the same, but increment level was rather low in case of liver irradiation. The increment of amino acids is mainly caused by the disorder of the function conducting amino acids, accompanying with weak deamination of amino acids in the liver. Moreover, it has a causal relation with the destruction of tissue protein by irradiation, a secondary functional disorder of the liver caused by the circulation disorder and cyto-toxic action to the hepatic cells through antigen-antibody reaction. Therefore, the changes of free amino acids in serum after irradiation can be a biochemical indicator for radiation injury. (auth)

Radiation Effects on Cells

Refer also to abstracts 12852, 12853, and 12941.

12857 (AEC-tr-7548, pp 78-83) INFLUENCE OF RADIATION AND THE QUANTITATIVE RATIO OF INTERACTING CELLS ON THE EFFECT OF STIMULATION OF THE SYNTHESIS OF IMMUNOGLOBULINS IN A MIXED CULTURE. Mikhailova, A. A. (Inst. of Biophysics, Moscow). 1974. Translated from Radiobiologiya; 14: No. 1, 63-67(1974).

In the irradiation of one or both mixed cell populations in a mixed culture of cells of immune lymph nodes and intact bone marrow, the effect of stimulation of the synthesis of immunoglobulins, characteristic of nonirradiated mixtures, is observed only in the case of joint culturing of irradiated bone marrow cells with nonirradiated cells of immune lymph nodes. In the case of irradiation of cells of immune lymph nodes, as well as irradiation of both mixed populations, the effect of stimulation is absent. Variation of the quantitative ratio of interacting cells in the mixed culture all the way to a 1 : 4 ratio does not influence the magnitude of the effect. The greatest intensification of the synthesis of immunoglobulins is observed at a concentration of the cells to be mixed equal to $3.2 \cdot 10^7$ cells per ml. Possible mechanisms leading to stimulation of the synthesis of antibodies and nonspecific γ-globulins in a mixed culture are discussed. (tr-auth)

12858 (AEC-tr-7548, pp 84-90) STOCHASTICS OF THE DEVELOPMENT OF RADIATION DAMAGE TO CELLS AND THE SHAPE OF DOSE-SURVIVAL CURVES. Barsukov, V. S.; Malinovskii, O. V. (Leningrad Inst. of Nuclear Physics). 1974. Translated from Radiobiologiya; 14: No. 1, 68-73(1974).

The scheme of development of radiation damages leading to an impairment of the reproductive capacity of the cell for the case of damage to unique structures according to the all or nothing type is discussed. It was shown that under various experimental conditions, the shape of the dose versus effect curve may be determined by stochastic principles at different stages of development of the radiation damage. The concept of the stochastic realization of radiation damages, according to which in the repair of the bulk of the primary damages, the shape of the dose-effect curve is determined not by the stochastics of the orgin, but by the stochastics of the realization of the radiation damages in postradiation periods, was formulated. (tr-auth)

12859 (AEC-tr-7548, pp 91-95) ROLE OF ENDOGENOUS SUBSTANCES IN THE CREATION OF A BACKGROUND OF INCREASED RADIORESISTANCE. Communication 2. Radioprotective Action of Serotonin and Mexamine on Mammalian Cells Cultured in Vitro. Graevskaya, E. E.; Parkhomenko, I. M.; Kudryashov, Yu. B. (Moscow State Univ.). 1974. Translated from Radiobiologiya; 14: No. 1, 74-77(1974).

The radioprotective action of 5-HT and 5-MOT on SOC cells, cultured in vitro, was studied. It was found that these indolylalkylamines protect cells from irradiation to the same degree as MEA. The dose change factor (DCF) for MEA is equal to 1.45, for 5-HT 1.55, and for 5-MOT 1.35. It is suggested that a definite portion of the protective action of indolylalkylamines on mammals is associated with protection at the cellular level. (tr-auth)

12860 (AEC-tr-7548, pp 103-108) POSTRADIATION CHEMICAL PROTECTION OF MAMMALIAN CELLS FROM THE ACTION OF RADIATION. Kublik, L. N.; Mantsygin, Yu. A.; Plotnikova, E. D.; Eidus, L. Kh. (Inst. of Biological Physics, Pushchino, USSR). 1974. Translated from Radiobiologiya; 14: No. 1, 83-87(1974).

The postradiation protective effect of cysteamine on a culture of Chinese hamster cells and mouse hematogenic atom cells was studied according to the criterion of colony-forming ability of the cells. It was shown that after brief irradiation and rapid subsequent introduction of the protector, the survival of both types of cells increases 3 to 5-fold. When the interval between irradiation and introduction of the protector is increased from 1 to 10 min, the protective action is sharply weakened. It was established that the degree of protection may depend on the stage of the mitotic cycle, duration of the stay of the cells in contact with the protector, and a number of other conditions. (tr-auth)

12861 (AEC-tr-7548, pp 148-151) MITOTIC ACTIVITY OF HUMAN LYMPHOCYTES IN THE CASE OF IRRADIATION AT VARIOUS STAGES OF THE MITOTIC CYCLE. Sevan'kaev, A. V.; Kozlov, V. M. (Scientific Research Inst. of Medical Radiology, Obninsk, USSR). 1974. Translated from Radiobiologiya; 14: No. 1, 117-119(1974).

The influence of radiation on a cell population produces two basic effects: the appearance of chromosome aberrations and an inhibition of mitosis. In this work the dose dependence of the mitotic activity in a culture of human lymphocytes in the case of irradiation in different stages of the mitotic cycle was investigated. (ERB)

12862 (ANL-8070, pp 145-188) BIOPHYSICS. Danyluk, S. S. Dec 1973.

In Division of Biological and Medical Research annual report, 1973.

Biophysics research projects were focused on a broad range of topics including: studies employing mammalian cells in culture to examine responses of cell growth and regulatory mechanisms to challenge by ionizing and uv radiations and other toxic

agents; elucidation of circadian phenomena in eukaryotes, principally Tetrahymena but extending to small mammals (rats); determination of biomolecular structure of proteins, nucleic acids, and antitumor drugs by x-ray diffraction and magnetic resonance techniques; and development of clinical applications of stable isotopes in screening programs for various diseases. (auth)

12863 (EUR-5122(Vol.1), pp 315-330) BIOLOGICAL IMPLICATIONS OF MICRODOSIMETRY. I. Temporal Aspects. Rossi, H. H.; Kellerer, A. M. (Columbia Univ., New York). Mar 1974.

From fourth symposium on microdosimetry; Verbania, Italy (24 Sep 1973).

According to the theory of dual radiation action cellular injury by ionizing radiation is due to pairs of sublesions which in the case of low LET radiation are usually produced by statistically independent events due to separate particles (usually electrons). Therefore if low LET radiations are delivered at low dose rates repair processes can occur that may reverse sublesions before they have interacted with other sublesions, and the extent of such repair processes depends on the temporal distribution of absorbed dose. In contrast there is no influence of the temporal distribution of absorbed dose on that component of cellular damage that is due to the interaction of lesions produced in the same particle track, and which is dominant in the case of densely ionizing radiations. Various aspects of the problem will be considered and theoretical interpretations of experimental results will be given. (auth)

12864 (EUR-5122(Vol.1), pp 331-351) BIOLOGICAL IMPLICATIONS OF MICRODOSIMETRY. II. Spatial Aspects. Kellerer, A. M.; Rossi, H. H. (Columbia Univ., New York). Mar 1974.

From fourth symposium on microdosimetry; Verbania, Italy (24 Sep 1973).

If the theory of dual radiation action is applied not to temporal phenomena but to the analysis of spatial interaction of cellular damage, additional complexities arise. As far as the interaction of sublesions is concerned, the quadratic dependence of the effect on specific energy, z, appears to be well established. It explains the observed RBE of different radiation qualities in a good first approximation. One must, however, also consider the effectiveness with which various radiations produce sublesions. Recent studies have indicated that this effectiveness is not completely independent of LET, and the specific energy at the nanometric level could therefore be a determining factor. The question is discussed with special reference to cellular inactivation cross-sections in the presence and absence of oxygen, and with reference to the very high RBE values observed at low doses of neutrons with energy of the order of 1 MeV. (auth)

12865 (EUR-5122(Vol.1), pp 381-403) RBE-LET RELATIONSHIP. Leenhouts, H. P.; Chadwick, K. H. (EURATOM-ITAL, Wageningen, Netherlands). Mar 1974.

From fourth symposium on microdosimetry; Verbania, Italy (24 Sep 1973).

A molecular theory of cell survival was based previously on the assumption that DNA double strand breaks are the most critical lesions in radiobiology. The coefficient "a" derived in the theory contains a parameter that represents the probability that the two strands of the DNA molecule are both crossed by one ionizing track. The track model of Mozumder, Chatterjee, and Magee coupled to a development of the arguments of Neary and Burch is used to calculate the dependence of "a" on radiation quality. The calculated values are compared with experimental data from the literature on the induction of DNA double strand breaks and cell survival. Analysis of cell survival data has shown that the coefficient "a" goes through a minimum in the S phase and an explanation has been suggested that this is due to the partial opening of the DNA strands at the replication forks in synthesis. The difference between the maximum and minimum values of "a" should be dependent upon the degree of opening of the strands and the radiation quality. Calculations of the variation in "a" are made for different radiations and are compared with analyzed experimental data. The implications of the results are discussed with respect to the structure of the biological target. (auth)

12866 (EUR-5122(Vol.1), pp 405-413) CELLULAR REPAIR AND RECOVERY AFTER RADIATION DAMAGE. Wideroee, R. Mar 1974.

From fourth symposium on microdosimetry; Verbania, Italy (24 Sep 1973).

A calculation of repair and recovery processes for irradiation-damaged mammalian cells using the "multitarget-equation" for cell-survivals is presented. The investigation is based on the 2-component theory of radiation. Measurements of Hall et. al. with low dose-rate irradiations give a time constant of 6¾ hours for the recovery of Hela cells. (auth)

12867 (EUR-5122(Vol.1), pp 415-439) COMPARISON OF TWO-COMPONENTS MODELS OF CELLULAR SURVIVAL. Neufeld, J.; Wright, H. A.; Hamm, R. N. (Oak Ridge National Lab., TN). Mar 1974.

From fourth symposium on microdosimetry; Verbania, Italy (24 Sep 1973).

The "two-component" models for estimating the survival of irradiated mammalian cells in proliferating cell cultures independently formulated by P. Todd, R. Widerõe, and R. Katz have been critically examined. In these formulations survival curves have been approximated empirically in terms of two different mechanisms, one, an irreversible mechanism expressed as "ion kill" by Katz and as "α-effect" by Widerõe and, two, a reversible mechanism expressed as "gamma kill" by Katz and as "β-effect" by Widerõe. Relationships between parameters obtained from these models have been derived and examined in the light of experimental evidence based on the work of G. W. Barendsen and P. Todd. An important aspect in the formulations of R. Katz and of R. Widerõe is the assessment of that fraction of the total absorbed energy which produces reproductive death by means of the irreversible mechanism. This is significant for radiotherapy since effects of the oxygen concentration are different for reversible and irreversible mechanisms. This fraction and other significant parameters differ in the models discussed. The models of Todd, Widerõe, and Katz have been examined from the point of view of their prognostic ability in determining survival curves for those radiations for which experimental information may not be available. (auth)

12868 (EUR-5122(Vol.1), pp 585-605) CHROMOSOME ABERRATIONS AND CELL DEATH. Chadwick, K. H.; Leenhouts, H. P. (EURATOM-ITAL, Wageningen, Netherlands). Mar 1974.

From fourth symposium on microdosimetry; Verbania, Italy (24 Sep 1973).

A quantitative correlation between cell death and chromosome aberrations was derived, which is based on a recent concept of chromosome structure and the assumption that radioinduced DNA double strand breaks are the most critical lesions in cellular radiobiology. There is some recent support for the proposal that a chromosome has a single DNA double helix backbone. A double strand break in the DNA is thus a break in the chromosome backbone which may lead to a chromosome aberration. A relationship between DNA double strand breaks and cell death has been demonstrated previously. The induction of chromosome aberrations and cell death are related to each other in this paper, via radiation induced DNA double strand breaks. The analysis of experimental results using the theoretically derived relationship is shown to lead to a highly significant correlation independent of cell phase and the use of a radiosensitizing agent. The theoretical considerations lead to some new proposals with regard to chromosome aberration formation. The experimental evidence in support of these proposals will be discussed and their application to the explanation of various phenomena in radiation cytology will be demonstrated. (auth)

12869 RADIOSENSITIVITY OF INOCULATED TUMOR WITH ITS COOLING. Dosakhanov, A. Kh.; Kauashev, S. K. (Scientific-Research Inst. of Oncology and Radiology, Alma-Ata, USSR). Med. Radiol.; 19: No. 6, 46-49(Jun 1974). (In Russian).

On the basis of the experiments made over 90 white mongrel male rats with primary tumor PC-I a relation was noted between the rate of cooling in non-medicinal hypothermia and radiosensitivity of the tumor. (auth)

12870 CLINICAL ASPECTS OF RADIATION PATHOLOGY OF OSTEOGENIC SARCOMA OF THE EXTREMITIES. Kuznetsova, I. P.; Frank, G. A.; Zvekotkina, L. S. (Moscow Scientific-Research Oncology Inst.). Med. Radiol.; 19: No. 6, 20-25(Jun 1974). (In Russian).

Comparison was made of the degree of radiation injury of the primary tumor which was determined morphologically according to plane sections in patients suffering from osteogenic sarcoma who had undergone amputation of the extremity at different times after the radiation treatment with the immediate results revealing a definite regularity: a longer life span was noted in patients in whom the injury of the tumor as a result of radiation effect was more marked. (auth)

12871 DISTRIBUTION OF X-RAY INDUCED CHROMOSOMAL ABNORMALITIES IN RAT KANGAROO (POTOROUS TRIDACTYLIS) CELLS IN VITRO. van Steenis, H. (Inst. of Hygiene and Epidermiology, Prague); Tuscany, R.; Leigh, B. Mutat. Res.; 23: No. 2, 223-228(May 1974).

Synchronized cells of Potorous tridactylis (female origin) were irradiated with x rays in vitro at different times during the cell cycle. Chromosome aberrations were scored in the first metaphase after irradiation. It is shown that the distribution of breaks

and gaps in the chromosome arms is different at different cell-cycle times, and is non-random. (auth)

12872 FREQUENCY AND DISTRIBUTION OF ISOLABELLING IN CHINESE HAMSTER CHROMOSOMES AFTER EXPOSURE TO X RAYS. Gatti, M.; Pimpinelli, S.; Olivieri, G. (Univ., Rome). Mutat. Res.; 23: No. 2, 229-238(May 1974).

Two experiments were carried out, following the same scheme. Chinese hamster cells (line CHEF-125) were cultivated for 4 h in the presence of tritiated thymidine ([^{3}H]TdR) (Expt. I, 0.5 μCi/ml; Expt. 2, 0.1 μCi/ml). After removal of the isotope, some of the cultures were x-irradiated in stage S-G_2 preceding M_1 (series S-G_2 I), others in stage S-G_2 preceding M_2 (series S-G_2 II). Analysis of the colchicine-C-anaphase of M_2 cells showed that in both experiments the x rays produced an increase in the isolabelling regions only if given in the S-G_2 stage preceding M_1. On the other hand, the x rays produced an increase in sister chromatid exchanges (SCEs) in both series of the second experiment. In the first experiment, where the controls had a high frequency of SCEs, no increase in SCEs was recorded in either of the two series treated with x rays. The frequency of the isolabelling regions, in relation to the total labelling (Expt. 2), was 1.4% in the control series, 2.5% in series S-G_2 I, and 1.3% in series S-G_2 II. Analysis of the distribution of the isolabelled regions along the chromosome showed that the regions furthest from the centromere were those most involved in this phenomenon and that, for the most part, the isolabelling was not directly associated with an exchange. The results have been interpreted, in accordance with the theory put forward in a previous work, to mean that SCEs and isolabelling regions are due to different phenomena, the former resulting from an exchange involving the whole chromatid, the latter from subchromatid exchanges probably involving a single polynucleotide strand. (auth)

12873 PREMATURE CHROMOSOME CONDENSATION. I. Visualization of X-Ray Induced Chromosome Damage in Interphase Cells. Hittelman, W. N.; Rao, P. N. (Univ. of Texas, Houston). Mutat. Res.; 23: No. 2, 251-258(May 1974).

A method is described to visualize chromosome damage in interphase cells immediately after exposure to mutagenic agents. This method involves the fusion of treated interphase cells with untreated mitotic cells that results in the induction of premature chromosome condensation (PCC). Chinese hamster ovary (CHO) cells were treated with x rays and chromosome aberrations were scored in G2-PCC and the mitotic chromosomes. The incidence of aberrations was significantly higher in PCC than that observed in the mitotic chromosomes of the treated cells. Post-irradiation incubation for 1 h before fusion allowed the repair of some of the chromosome damage. Data are also presented that indicate that the extent of radiation damage visualized in PCC is inversely proportional to the degree of chromosome condensation. These results indicate that the PCC method has a greater sensitivity in the detection of induced chromosome damage than the standard method of scoring metaphase chromosomes. (auth)

12874 PREMATURE CHROMOSOME CONDENSATION. II. Nature of Chromosome Gaps Produced by Alkylating Agents and Ultraviolet Light. Hittleman, W. N.; Rao, P. N. (Univ. of Texas, Houston). Mutat. Res.; 23: No. 2, 259-266(May 1974).

Chinese hamster ovary (CHO) cells were treated with ultraviolet radiation or the alkylating agents, nitrogen mustard or trenimon, and chromosome damage to G2 phase cells was scored by the premature chromosome condensation (PCC) method or the mitotic chromosome method. Treatment with these agents produced gaps but not chromatid breaks or exchanges. After uv treatment, the gap frequency observed in G2-PCC was higher than in the mitotic chromosomes, while the reverse trend was observed after treatment with nitrogen mustard or trenimon. These results suggest that two types of chromosome gaps exist, both of which are observable in mitotic chromosomes while only one type is observable in PCC due to differences in the stages of condensation between PCC and mitotic chromosomes. (auth)

12875 CHEMICAL MUTAGENS. Principles and Methods for Their Detection. Volume 1. Hollaender, A. (ed.). New York; Plenum Publishing Corporation (1971). 320p. $17.50.

The mechanisms of mutagenesis and the detection of chemical mutagens are discussed under the following headings: molecular mechanisms of mutations; correlation between teratogenic and mutagenic effects of chemicals in mammals; the mutagenicity of chemical carcinogens; effects on DNA; detection of the effect of mutagens on DNA; transforming principle; mutagen screening with virulent bacteriophages; prophage induction in lysogenic bacteria as a method of detecting potential mutagenic, carcinogenic, carcinostatic, and teratogenic agents; the detection of chemical mutagens with enteric bacteria; mutagenesis studies with Escherichia coli mutants with known amino acid (and base-pair) changes; and mutation induction in yeasts. (ERB)

12876 CHEMICAL MUTAGENS. Principles and Methods for Their Detection. Volume 2. Hollaender, A. (ed.). New York; Plenum Publishing Corporation (1971). 362p. $17.50.

The action of mutagens and the mechanisms of their actions in a variety of organisms are discussed under the following headings: measurement of recessive lethal damage in Neurospora crassa; Aspergillus; higher plants; diploid cell culture and meiotic chromosome preparation; gene mutations in mammalian cells in culture; inducing mutations with chemicals in Habrobracon; the detection of mutations in Drosophila melanogaster; root tips for studying the effects of chemicals on chromosomes; cytogenetic studies in animals; specific locus mutations in mice; evaluating potential mutagenic agents in mammals; and human population monitoring. (ERB)

12877 CHEMICAL MUTAGENS. Principles and Methods for Their Detection. Volume 3. Hollaender, A. (ed.). New York; Plenum Publishing Corporation (1973). 324p. $19.50.

The purpose of this volume is to discuss in some detail the techniques of some of the methods, discussed previously from a theoretical point of view, for detecting the activity of mutagenic agents and to update this rapidly expanding field with current findings. The following topics are discussed in the volume: history of research on chemical mutagenesis; observations on meiotic chromosomes of the male mouse; techniques for monitoring and assessing the significance of mutagenesis in human populations; specific-locus mutational assay systems for mouse lymphoma cells; monitoring human populations for mutation rates and genetic disease; repairs of chemical damage to human DNA; Tradescantia stamen hairs as test system for chemical mutagenesis; detection of genetically active chemicals using various yeast systems; chemical effects on total reproductive capacity in female mice and their analysis; insect chemosterilants as mutagens; and the literature of chemical mutagenesis. (ERB)

12878 CHROMOSOME STRUCTURE AND FUNCTION. Conference Held at Cold Spring Harbor, NY, May 31-June 6, 1973. Cold Spring Harbor Symposia on Quantitative Biology, Volume XXXVIII. Cold Spring Harbor, NY; Cold Spring Harbor Laboratory (1974). 1030p. (CONF-730593-). $30.00.

The 95 papers given at the conference are presented under the following general headings: physical organization of DNA in chromosomes; organization of chromosomes within the nucleus; DNA replication; repeated sequences and their arrangement in chromosomes; the genes for ribosomal and transfer RNA; chromosomes and bands; loops, puffs, and Balbiani rings; structural genes and their products; chromatin; and transcription. (ERB)

12879 COMPARISON OF IRRADIATED AND MITOMYCIN-TREATED MOUSE SPLEEN CELLS AS STIMULATING CELLS IN MIXED LYMPHOCYTE CULTURES AND IN VITRO SENSITIZATION. Hodes, R. J.; Terry, W. D. (National Cancer Inst., Bethesda, MD). J. Immunol.; 113: No. 1, 39-44(Jul 1974).

Mitomycin-treated and irradiated mouse spleen cells were compared as stimulating cells in allogeneic mixed lymphocyte culture (MLC) and as sensitizing cells in in vitro allogeneic sensitization. C57BL/6 and BALB/C spleen cells were irradiated at doses up to 5000 rads or treated with mitomycin C to inhibit DNA synthesis. Irradiated cells, as well as mitomycin-treated cells, were efficient both in stimulating MLC and in sensitizing in vitro. (auth)

Radiation Effects on Microorganisms

Refer also to abstracts 12847, 12849, 12853, and 12941.

12880 (AEC-tr-7548, pp 64-70) RADIOBIOLOGICAL CHARACTERISTICS AND ABILITY FOR RECOVERY FROM RADIATION DAMAGES OF YEAST ORGANISMS OF VARIOUS TAXONOMIC GROUPS. Sokurova, E. N. (Scientific Research Inst. of Medical Radiology, Obninsk, USSR). 1974. Translated from Radiobiologiya; 14: No. 1, 53-57(1974).

The radiosensitivity and ability for recovery were investigated in 21 species of yeasts. The values of D_0 and LD_{99} in diploid species are more variable than in haploid species. Haploid species are characterized by exponential survival curves, and as a rule, by the absence of ability for recovery. Diploid yeasts are characterized by sigmoid survival curves with various sized shoulders, and as a rule, are capable of recovery from radiation damages. Species of yeasts belonging to imperfect genera give both exponential and sigmoid survival curves. It is suggested that some imperfect species reproduce vegetatively in the

haplophase, and others in the diplophase. It was shown that the radiosensitivity of the investigated yeast species does not depend on the size of the cells, as well as on the DNA content, calculated per cell or per genome. (tr-auth)

12881 (AEC-tr-7548, pp 71-77) PECULIARITIES OF THE PHOTOREACTIVATION OF BACTERIOPHAGE T1, IRRADIATED IN THE FORM OF COMPLEXES WITH CELLS OF E. COLI B AT EARLY STAGES OF INFECTION. Mosin, A. F.; Petrova, K. M.; Tsyb, T. S. (Scientific Research Inst. of Medical Radiology, Obninsk, USSR). 1974. Translated from Radiobiologiya; 14: No. 1, 58-62(1974).

The kinetics and magnitude of the photoreactivation of phase T1, subjected to uv irradiation at early stages of infection of cells of E. coli B, differ substantially from the kinetics of the photoreactivation of phage irradiated in the free state and are determined chiefly by the moment of infection at which irradiation occurs. The penetration of phage DNA into the cytoplasm of the cell and the irradiation of the host cell in complex with the phage probably do not play the determining role in the photoreactivation of bacteriophage. The aggregate of data obtained indicates a possible significance of the interaction of the phage DNA with cell membranes for the ability of the phage for photoreactivation. (tr-auth)

12882 (ANL-8070, pp 109-144) BIOCHEMISTRY. Thomson, J. F. Dec 1973.

In Division of Biological and Medical Research annual report, 1973.

The research activities of the biochemistry group are diverse, encompassing studies on animals, plants, microorganisms, tumor cells, cellular particles, and purified enzymes, and employing a variety of experimental techniques to investigate a number of physiological processes. Progress is reported on studies on the preparation and properties of single cells and subcellular particles; biochemical manifestation of x radiation damage in yeast cells; hormonal and metabolic bases of radiation response in γ irradiated plants; and the therapy of poisoning by radioactive and nonradioactive metals, with emphasis on methods for the removal of Pu from mammals. (CH)

12883 (ANL-8070, pp 189-213) MOLECULAR AND RADIATION GENETICS. Kubitschek, H. E. Dec 1973.

In Division of Biological and Medical Research annual report, 1973.

The overall program in molecular genetics is directed toward an integrated understanding of the nature of genetic material, and its organization, function, regulation, and replication in the living cell. These employ radiation studies, either to investigate the nature of radioinduced lesions, or as a tool for genetic studies, or both. Data are included from studies on bacteria and bacteriophages. (CH)

12884 (EUR-5122(Vol.1), pp 441-461) INTERPRETATION OF THE OXYGEN EFFECT. Kiefer, J. (Justus Liebig-Univ., Giessen, Ger.). Mar 1974.

From fourth symposium on microdosimetry; Verbania, Italy (24 Sep 1973).

Current hypotheses concerning the radiobiological oxygen effect involve two types of damage, so called type O and type N damage. It has been shown recently (Kiefer and Averbeck, Int. J. Radiat. Biol., in the press) that at least in yeast cells exposure in air or nitrogen exerts its action at the same cellular site. On the basis of these results a simple unified kinetic model of the oxygen effect has been developed; the mathematical formalism leads to the well known "Alper-formula" for the dependence of OER on oxygen concentration, thus showing that the assumption of type O and type N damage affecting different parts of the cell is not a necessary prerequisite for the experimentally found behavior. The model allows an estimation of the life-time of radiation induced intermediates reacting with oxygen being compatible with recent experimental results. The influence of LET, as well as of radiosensitizer action will be discussed in terms of the model proposed. (auth)

12885 MUTANTS OF ANACYSTIS NIDULANS WITH MODIFIED PROCESS OF CELL DIVISION. Zhevner, V. D.; Glazer, V. M.; Shestakov, S. V. (Moscow State Univ.). Mikrobiologiya; 42: No. 2, 290-297(1973). (In Russian).

Stable fil-mutants with a modified process of the formation of septa were isolated from the unicellular blue-green alga Anacystis nidulans. The morphology of the colonies and the cells and the population heterogeneity of four mutants, forming filamentous multinucleoid cells, were studied. Atypical filaments with unsegregated nucleoplasm were detected in the population of a mutant fil-N11. Fil-mutants do not differ from the wild type strain by the content of DNA per dry weight of the cells. Fil-mutants are more resistant to penicillin than the wild type but are more sensitive to mitomycin C. The majority of the mutants (except fil-N11) do not reveal a decrease of the resistance to x rays and methylmethane sulphonate. Some mutants are more sensitive to high doses of uv. A high level of the radiosensitivity of the mutant fil-N11 is due to the additional mutation. The properties of the filamentous mutants of A. nidulans suggest that changes of cytokinesis in the mutants do not depend on damages in the systems of DNA repair. (auth)

12886 COMBINED EFFECT OF CHEMICAL COMPOUNDS AND γ RADIATION ON THE CELLS OF BLUE-GREEN ALGA ANACYSTIS NIDULANS. Dmitriev, A. P.; Grodzinskii, D. M. (Inst. of Plant Physiology, Moscow). Mikrobiologiya; 42: No. 2, 307-311(1973). (In Russian).

The radiosensitizing effect of m-iodobenzoic acid and methylhydrazine on the cell survival was studied with the blue-green alga Anacystis nidulans which manifested a considerably high radioresistance. The technique of the cultivation of the cells on solid media was applied for the investigation of the modification of the radiosensitivity of the cells of A. nidulans. Methylhydrazine at a non-toxic concentration was found to sensitize the cells of A. nidulans to γ radiation both under anoxic and aerobic conditions. The radiosensitivity of the alga increased in the presence of m-iodobenzoic acid only under anoxic conditions. Possible mechanism of the radiosensitizing effect is discussed. (auth)

12887 PRODUCTION OF MUTANTS OF RHIZOBIUM TRIFOLII WITH MODIFIED SPECIFICITY. Imshenetskii, A. A.; Pariiskaya, A. N. Mikrobiologiya; 42: No. 2, 298-300(1973). (In Russian).

The treatment of clover nodule bacteria with uv and nitrosomethylurea brought about mutants capable of nodule formation on the roots of alfalfa. The method for the selection of the mutants with modified specificity by means of plants is suggested. The advantages and limitations of this method are discussed. (auth)

12888 SENSITIZATION OF PHOTOREACTIVATION OF YEAST CELLS WITH NEUTRAL RED AND ACRIFLAVINE DYES. Panastuk, N. V. (Lvov State Univ.). Mikrobiologiya; 42: No. 2, 255-259(1973). (In Russian).

Yeast cells grown on solid media containing neutral red or acriflavine dyes were found to have a higher photoreactivability than the control. The effect depends on the wavelength of photoreactivating light and is more pronounced at 436 nm than at 365 nm. This fact is confirmed by the absorption spectra of the dyes and suggests the migration of energy from the dyes onto the photoreactivating system. (auth)

12889 RECOMBINATION ABILITY, VIABILITY, AND UV-SENSITIVITY OF THE ESCHERICHIA COLI STRAIN REC B^- REC C^- SBC B^- UVR E^-. Smirnov, G. B. (Inst. of Epidemiology and Microbiology, Moscow). Genetika; 10: No. 4, 102-108(Apr 1974). (In Russian).

The effect of the uvr E502 mutation on the Rec F pathway of repair and recombination was studied. The repair pathway determined by the uvr E^+ gene was independent on the Rec BC-mediated repair. The yields of recombinants obtained in the crosses with the rec B^- rec C^- sbc B^- uvr E^- recipient were much lower than that in the crosses with the isogenic uvi E^+ strain mostly due to apparent inviability of the great majority of the former recipient. The uvr E^- derivative of the rec B^- rec C^- sbc B^- strain was somewhat recombination deficient even when its low viability was taken into account. Low viability of the rec B^- rec C^- sbc B^- uvr E^- strain was accompanied by the disturbance of cell division (filament formation) taking place in more than 90% of the cells, while among the rec B^- uvr E^- cells only 10% showed filamentation. (auth)

12890 GENETIC CONTROL OF SENSITIVITY TO MUTAGENIC FACTORS IN ASPERGILLUS NIDULANS. V. Effect of uvs Mutation on Postradiation Influence of Acriflavine and Capacity of uv-Treated Conidia for Photoreactivation During Incubation in Buffer. Kameneva, S. V.; Romanova, Yu. M.; Furletova, N. M. (Moscow State Univ.). Genetika; 10: No. 4, 109-119(Apr 1974). (In Russian).

An effect of acriflavine and caffeine on the survival rate of uv-treated conidium in uvs^+ and 6 uvs strains of Aspergillus nidulans and also kinetic investigations of decreased capacity to the photoreactivation of the conidium, incubated in the buffer, were studied. The treatment with caffeine and acriflavine of irradiated conidium of uvs^+ strain caused an increase in lethal action of uv: acriflavine was the more effective. The effect was not observed in conidium of uvs mutants or it was less distinct than in uvs^+ strain. Under incubation of uv-treated conidium of uvs^+ strain in the buffer the capacity of lethal impairments to the photoreactivation disappeared within 4 hrs. In two uvs mutants the photoreversibility

maintained for a longer period. On the basis of results obtained some assumptions about the nature of uvs mutations were discussed. (auth)

12891 UV-MUTAGENESIS IN BACILLUS SUBTILIS. III. Comparison of Sensitivity of Some Strains to Inactivating and Mutagenic Effects of Ultraviolet Light. Lotareva, O. V.; Filippov, V. D. (Inst. of General Genetics, Moscow). Genetika; 10: No. 4, 135-141(Apr 1974). (In Russian).

Survival curves for uv-irradiated cells of Bacillus subtilis strains of wild type (WT), uvr, 1306 (polI), and 342 (rec_x) as well as frequencies of revertants to prototrophy induced by uv in these strains have been determined. Uvr cells do not excise pyrimidine dimers from damaged DNA and are able to be transformed with normal frequency. PolI cells have strongly lowered capability to serve recipients in transformation; cells of a strain 342 possess reduced activity of ATP-dependent DNase, they are poorly transformed by the low DNA concentration. The susceptibility of strains to inactivating effect of uv increases in the following order: WT ≤ rec_x ≪ uvr < polI; the mutability toward uv does in the next order: WT ≈ rec_x < polI ≪ uvr. Data obtained are interpreted as an indication on the similarity between the mechanisms of uv mutagenesis in Bac. subtilis and E. coli. (auth)

12892 INDUCED MUTATIONS IN SERRATIA MARCESCENS BY NEAR UV-LIGHT IN PRESENCE OF PSORALEN. Joseph, R.; Shanthamma, M. S.; Rehana, F.; Nand, K. (Central Food Technological Research Inst., Mysore, India). Experientia; 30: No. 4, 360-361(15 Apr 1974).

The mutagenic effects of near uv-light (350 to 360 nm) in combination with 8-methoxy-psoralen on Serratia marcescens were studied. The results indicate that the combination gave a considerable yield of auxotrophs and color variants with only moderate killing of the cells. (ERB)

12893 IMMUNOGENICITY OF PURIFIED, INACTIVATED CHIKUNGUNYA VIRUS IN MONKEYS. Nakao, E.; Hotta, S. (Kobe Univ., Japan). Bull. World Health Organ.; 48: 559-562 (May 1973).

Chikungunya (CHIK) virus, harvested from infected BHK-21 cell cultures and highly purified by a method combining zinc acetate precipitation, Sephadex–Sepharose column chromatography, and sucrose density gradient centrifugation, was subjected to ultraviolet (uv) irradiation and treatment with formalin. Inactivation of the virus by uv light was apparently a first-order reaction. The virus treated with 0.05% formalin at 4°C was inactivated completely after 7 weeks, but when treated with 0.025% formalin retained its plaque infectivity at least 17 weeks. Both uv- and formalin-inactivated viruses induced production of anti-CHIK neutralizing antibodies in Japanese monkeys with no preimmune antibodies. Judging by the titres of antibodies produced, the immunogenic effect of the uv-irradiated virus was superior to that of the formalin-treated virus. (auth)

12894 EFFECTS OF NUTRIENTS AND ENVIRONMENT ON GERMINATION AND LONGEVITY OF OOSPORES OF PYTHIUM HYDNOSPORUM. Hassan, K. K.; Fergus, C. L. (Pennsylvania State Univ., University Park). Mycopathol. Mycol. Appl.; 51: No. 4, 283-297(1973).

Oospores germinated in distilled water, but the addition of nutrients increased the percent germinating. A germ tube emerged which quickly elongated into a branched aseptate hypha. Germination occurred over a wide range of temperature. Germinability decreased with age of culture. The incubation temperature and the addition of cholesterol to the medium affected germination percentage. Oospores, formed in cultures on media to which cholesterol was added, were more resistant to heat and to ultraviolet radiation. Oospores survived 2 hours exposure to 50°C. Oospores formed on mushroom compost survived 18 months at 25°C. (auth)

12895 EFFECT OF VISIBLE AND UV LIGHT RAYS ON THE ACTIVITY OF OXIDATIVE ENZYMES IN MOLD FUNGI. Chebotarev, L. N.; Zemlyanukhin, A. A. (Lvov State Univ.). Mikrobiologiya; 42: No. 2, 220-225(1973). (In Russian).

The effect of visible light and uv on the activity of oxidation enzymes was studied in mold fungi. These factors were able to stimulate or to inhibit the enzyme activity: this depended on the dose and intensity of the irradiation. These effects were more pronounced in the non-pigmented fungi than in the pigmented fungi. The mechanism of inactivation was different and depended on the enzyme structure. (auth)

12896 PHOTOREACTIVATION OF EXCYSTMENT DELAY IN COLPODA, INDUCED BY FAR ULTRAVIOLET RADIATION. Giese, A. C. (Stanford Univ., CA). Exp. Cell Res.; 83: 73-78(Jan 1974).

No photoreactivation (PR) was observed in dry cysts of Colpoda inflata irradiated with either monochromatic 265 nm far uv radiation or with polychromatic radiation from an argon plasma arc lamp filtered through a sapphire window with a cutoff at 145 nm. Wet Colpoda cysts, however, showed a high degree of PR, especially after large uv doses from either source listed above. PR was achieved using two lamps, each with two 4 watt cool white fluorescent bulbs 8 cm from the cyst preparation; an exposure of 4 or more hours was required for maximal PR. Wet cysts were damaged by much smaller dosed of far uv than were dry cysts; such damage is, however, also subject to PR. It is probable that PR fails in dry cysts because the photoenzyme which provides energy for PR by absorbing visible and near uv radiation is unable to act in the absence of water. (auth)

12897 ^{125}I VERSUS ^{75}Se LABELING OF FIBRINOGEN FOR MEASURING TURNOVER OF CANINE FIBRINOGEN. Owens, C. A.; Bowie, E. J. W. (Mayo Clinic, Rochester, MN). Proc. Soc. Exp. Biol. Med.; 146: No. 2, 349-351(Jun 1974).

Apparent turnover of fibrinogen in normal mongrel dogs was observed to be consistently greater when ^{125}I-labeled fibrinogen (canine) was used than with the Brodsky technique ([^{75}Se] methionine): 4.79 vs 1.96 mg/dl plasma per hour, respectively. When the labeled amino acid was given intravenously to three dogs and their blood was transfused into three other dogs 1 to 5 days later, only slight differences in fibrinogen turnover were observed between blood donors and recipients, suggesting negligible reutilization of [^{75}Se] methionine. It would seem that the ^{125}I-labeled fibrinogen was degraded rapidly in vivo because of some intrinsic alteration in the labeled material. (auth)

12898 INACTIVATION OF BACTERIOPHAGES BY IRRADIATION WITH DIFFERENT LET. Abel, H.; Erzgreber, G.; Tolkendorf, E. (Polska Akademia Nauk, Warsaw). Artif. Satell.; 8: 185-190(Nov 1973). (In Russian).

From symposium on cosmic biology and medicine; Warsaw, Poland (12 Jun 1972).

Two varieties of bacteriophages (T prime and T second) were bombarded with light nuclei and heavy ions in bouillon with and without radioprotector (cysteine). The nature of inactivation of bacteriophages by bombardment is discussed with attention to the role of enzymes in the bacteriophage recovery process. (IAA)

12899 uvrC GENE IN SALMONELLA: PHENOTYPIC PROPERTIES AND A PRELIMINARY MAPPING. Skavronskaya, A. G.; Andreeva, I. V.; Kiryushkina, A. A. (Gameleya Inst. for Epidemiology and Microbiology, Moscow). Mutat. Res.; 23: No. 2, 275-277(May 1974).

A new uv-sensitive mutant of Salmonella typhimurium AG47 uvrC337 was isolated from S. typhimurium SL4522 population after EMS treatment. The phenotype of the mutant and the location of mutation seem to be similar to those of the uvrC mutants of Escherichia coli. (ERB)

12900 KINETICS OF PHOTOREACTIVATION IN THE ULTRAVIOLET-SENSITIVE MUTANT ESCHERICHIA COLI K12 AB2480. Tyrrell, R. M.; Davies, J. G. (Univ. of Bath, Eng). Mutat. Res.; 23: No. 2, 151-161(May 1974).

An investigation of the kinetics of photoreactivation (PR) in stationary phase cells of the uv-sensitive Escherichia coli mutant K12 AB2480 revealed an initial fast rate of PR which can be attributed to the photolysis of photoreactivating enzyme-substrate complexes already in existence at the start of the illumination period. The initial fast rate could be eliminated by administering a single high intensity flash at the start of continuous illumination. This experimental technique allowed the recognition of two additional rate processes during continuous illumination. The first order rate constant for the faster rate process (k_f) leads to a value of 4 to 5 photoreactivating enzyme (PRE) molecules per cell for 16 h nutrient broth grown cells. A photoreactivating irradiance of approx. 60 erg mm^{-2} sec^{-1} saturates the reaction and under saturating conditions we obtain a value for the activation energy of the fast rate of 9 kcal $mole^{-1}$. (auth)

Radiation Effects on Plants

Refer also to abstracts 12882 and 12941.

12901 (AEC-tr-7548, pp 185-187) ROLE OF UNDERDEVELOPMENT OF THE EMBRYO IN THE RADIOSENSITIVITY OF SEEDS. Preobrazhenskaya, E. I. (Agrophysical Scientific Research Inst., Leningrad). 1974. Translated from Radiobiologiya; 14: No. 1, 145-146(1974).

Two-stage stratification of Aralia mandshurica seeds was used in all the groups: warm (three months at 18 to 23°C) and cold (four months at 3-5°C). The seeds were irradiated with the γ

rays of ^{60}Co at four periods, covering different states of the embryo: I, before warm and cold stratification; II, 1.5 months after the beginning of warm stratification; III, after warm stratification; and IV, after complete warm and cold stratification. After passage through all the variations of the experiment of two-stage stratification, the seeds were germinated in petri dishes at room temperature, and the seeds that germinated were counted. The experiment was conducted in one repetition. However, a large number of seeds (~1100) was used in each variation. The results obtained were treated statistically. (ERB)

12902 (AEC-tr-7548, pp 188-191) CHANGES IN THE QUANTITATIVE RATIOS OF THE PROTEIN FRACTIONS OF RIBOSOMES OF THE COTTON PLANT IN THE NORMAL STATE AND AFTER γ IRRADIATION. Ibragimov, A. P.; Rakhmatov, N. A. (Inst. of Biochemistry, Tashkent, USSR). 1974. Translated from Radiobiologiya; 14: No. 1, 147-149(1974).

It is known that inhibition of RNA biosynthesis may lead to an inhibition of the biosynthesis of ribosomal protein. In view of this, an attempt was made to determine the influence of γ irradiation on the fractional composition of the proteins of cotton plant ribosomes. (ERB)

12903 (AEC-tr-7548, pp 192-197) INFLUENCE OF GAMMA RAYS ON THE GROWTH AND DEVELOPMENT OF RECIPROCAL INTERVARIETY HYBRIDS OF FINE-FIBER COTTON PLANTS. Mamedov, K. (Inst. of Botany, Ashkhabad, USSR). 1974. Translated from Radiobiologiya; 14: No. 1, 150-154(1974).

The influence of various doses of the γ rays of ^{137}Cs on the growth, development, and radioresistance of varieties and hybrids of the species G. barbadense L. at various periods of their ontogenesis is elucidated. (ERB)

12904 (AEC-tr-7548, pp 198-200) INFLUENCE OF PRELIMINARY GAMMA IRRADIATION ON THE SUBSEQUENT RADIOSENSITIVITY OF PEA SEEDS. Pozolotin, A. A.; Al'shits, L. K. (Inst. of the Ecology of Plants and Animals, Sverdlovsk, USSR). 1974. Translated from Radiobiologiya; 14: No. 1, 154-156(1974).

In the irradiation of pea seeds of the Kapital and Krasnoufimskii-70 varieties (moisture content 12%), the doses of preliminary irradiation (dose I) or the doses of repeated irradiation (dose II) were varied. The criterion of the reaction was the frequency of cells with chromosome aberrations at the anaphase stage of the root meristem of the seedlings at the end of the first postradiation mitosis. The control was nonirradiated seeds as well as seeds irradiated in the swollen state at dose II, but not subjected to preliminary irradiation at dose I. (tr-auth)

12905 (COO-3217-26) APPLICATION OF NUCLEAR ENERGY TO AGRICULTURE. Progress Report, April 1, 1973-March 31, 1974. Moh, C. C. (Tropical Agricultural Research and Training Center, Turrialba (Costa Rica)). 1974. Contract AT(11-1)-3217. 29p. Dep. NTIS $4.50.

Cassava (Manihot esculenta) is a tropical plant producing roots that serve as a staple food for the people in the tropics. The roots are rich in carbohydrates and provide a major source of calories to 200 to 300 million people. Plants producing more than 20 lb of fresh roots are not uncommon and a production of 20 to 30 tons of roots per acre has been reported. There are two inherent characteristics in cassava that are considered to be undesirable. One is the relatively long growth period for root maturity, (10 to 12 months after the stem cuttings are planted in the ground), and the other is the presence of cyanogenic glucosides, which have a possible toxic effect on humans. The mutation breeding technique was used to obtain cassava cultivars of early root maturity and low cyanoglucoside content following irradiation of pollen. Plant breeding programs using radioinduced mutants of black beans (Phaseolus vulgaris) to produce white beans and radioinduced mutants to produce dwarf compact coffee plants (coffea arabica) are discussed briefly. (CH)

12906 (EUR-5122(Vol.1), pp 519-543) COMPARATIVE STUDY OF THE RADIOINDUCED CHROMOSOME ABERRATIONS IN ONION ROOTS (ALLIUM CEPA) DURING ACUTE IRRADIATION AND LOW-LEVEL CONTINUOUS IRRADIATION. Prignot, M.; Wambersie, A.; Laublin, G.; van Pottelsberghe, C.; Bouharmont, J. (Tumor Center, Louvain, Belgium). Mar 1974. (In French).

From fourth symposium on microdosimetry; Verbania, Italy (24 Sep 1973).

The effects of low dose-rate irradiations (^{192}Ir at 2 rads/min and radium at 0.5 rad/min) were compared to those obtained by irradiations with ^{60}Co at 150 rads/min, taking as biological criterion the production of chromosomal aberrations in onion roots (Allium cepa). Three criteria were considered: the percentage of cells with (at least) one "fragment"; the mean number of "fragments" per cell; and the percentage of cells with (at least) one "bridge", for cells in anaphase and telophase. Doses ranging from 75 to 250 rads were delivered. The aberrations were scored by two independent observers in order to reduce the influence of any subjective factor. For the different considered criteria and dose-rates, linear dose-effect relations were observed with significant positive slopes. The ratios of the slopes for ^{192}Ir and radium compared to ^{60}Co were found respectively 0.8 and 0.75 for the three criteria. Moreover, similar distributions of the number of fragments per cell have been found. As a consequence, no differential effect related to the dose-rate has been observed. The possible influence of several factors is discussed such as: relative importance of the one step and two steps processes, modification of the cell distribution in the mitotic cycle for low dose-rate irradiation, and RBE (this latter cannot account for more than a few percent). (auth)

12907 (INIS-mf-1291, pp 74) USE IN PLANT BREEDING OF ACUTE, CHRONIC OR FRACTIONATED DOSES OF X RAYS OR FAST NEUTRONS AS ILLUSTRATED WITH LEAVES OF SAINTPAULIA. Broertjes, C. (Instituut voor Toepassing van Atoomenergie in de Landbouw, Wageningen, Netherlands). 1972.

The parameters used were survival of irradiated leaves of S. ionantha, production of adventitious plantlets at the base of the petiole, and mutation frequency. The differences between unfiltered x rays from a 250/25 deep therapy apparatus and fast neutrons from a degraded fissions spectrum were slight and sometimes negligible. A striking dose rate effect was observed, especially with x rays. In fractionation experiments a protective mechanism was induced in leaves by pre-irradiation with either type of radiation. This mechanism reached a maximum after 8 to 12 h. Then the extent of the protection was equivalent to 3 krad x rays or 1.5 krad fast neutrons after a single pre-treatment with the optimum initial dose of 500 rad, x rays or fast neutrons. A 10 to 15 fold irradiation with this dose, separated by 8-h intervals, induced a protection of 6 to 7 krad x rays or 3 to 4 krad fast neutrons. Several of the treatments result in a higher number of mutants per 100 irradiated leaves compared with the optimum acute dose of 3 krad x rays or 1.5 krad fast neutrons. (INIS)

12908 (ORO-4241-4) STUDY OF THE BIOCHEMICAL EFFECTS OF IONIZING AND NONIONIZING RADIATION ON PLANT METABOLISM DURING DEVELOPMENT. Progress Report, September 1, 1973-August 31, 1974. Klein, W. H. (Smithsonian Institution, Rockville, Md. (USA). Radiation Biology Lab.). 1974. Contract AT(40-1)-4241. 66p. Dep. NTIS $6.50.

Results are reported from studies on Arabidopsis thaliana plants of the effects of spectral quality of light that can influence the phytochrome controlled germination of seeds. (CH)

12909 EFFECT OF GAMMA IRRADIATION ON RECOMBINATION IN RICE. Oryza sativa L. Omura, T. (Kyushu Univ., Fukuoka). Gamma Field Symp.; No. 10, 33-40(Mar 1973).

The effect of gamma irradiation on the recombination in rice, Oryza sativa L., was investigated. F_1 plants heterozygous for linked genes were exposed to ^{60}Co gamma ray in a gamma field, and nine marker genes were used in this study. The recombination value was calculated from F_2 segregation by the method of maximum likelihood. The recombination value strikingly increased in the regions of Pl (purple leaf)- lg (liguleless), C (chromogen for anthocyan pigmentation)- wsl (white-striped leaf), and g (long empty glume)-Rc (red pericarp) by the irradiation during reproductive stage, but not in the other region. Therefore, in rice, as well as in Drosophila and Chlamydomonas, the effect of irradiation on the recombination differs with different region. The sensitive stage during which the recombination is affected by the irradiation was not found in rice, though it was found in Drosophila and Chlamydomonas. The present results on the relationship between dosage and the effect of irradiation show that the changing recombination probably results from true crossover. (JA)

12910 TWO SEMIDWARFNESS GENES INDUCED FROM JAPONICA RICE, CHIANUNG 242 AND TAINAN 5. Woo, S. C.; Wu, W. H.; Tung, I. J. (Inst. of Botany, Taipei, Taiwan). Bot. Bull. Acad. Sinica (Taiwan); 15: No. 1, 54-56(Jan 1974).

Semidwarf mutants of japonica rice were induced by treatment with the following mutagens: EMS; γ radiation; x radiation; and combined x radiation and hydroxylamine. Genotypic and phenotypic relationships are discussed. (ERB)

Radiation Effects on Animals

Refer also to abstract 14402.

Man

Refer also to abstracts 12351, 12870, 13051, and 14699.

12911 (AEC-tr-7548, pp 128-135) SOME URGENT PROBLEMS IN RADIATION SICKNESS AND EXPERIMENTAL MEANS OF SOLVING THEM. Gus'kova, A. K. (Inst. of Labor Hygiene and Occupational Diseases, Moscow). 1974. Translated from Radiobiologiya; 14: No. 1, 102-107(1974).

Clinical data on the basic variations of radiation sickness of man in various radiation situations and the completeness of the clinico-experimental concepts of them are generalized. The models usually used in experiments and their adequacy to the clinical syndromes in man are compared. The most urgent problems for further experimental work are formulated. (tr-auth)

12912 (BNWL-SA-5013) IMPACT OF RADIATION ON MAN AND HIS ENVIRONMENT. Waite, D. A. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). May 1974. 6p. (CONF-740544-1). Dep. NTIS $4.00.

From environmental symposium; Centralia, Washington, USA (13 May 1974).

Man's exposure to radiation comes from both natural background radiation and man-made radioactive materials. Naturally occurring background radiation is composed of two components: terrestrial and cosmic. Man-made radiation originates from x-ray machines, accelerators, and the fission processes in nuclear reactors or nuclear weapon devices. The isolation and purification of naturally occurring radioactive materials, such as radium and uranium, has resulted in both the opportunity for beneficial use and beneficial impacts while also providing a concentrated source of naturally occurring radioactive material that could result in substantially increased levels of radiation exposure to those using these materials. The generation of man-made radioactive materials for special application or their generation as by-products of power generation in either reactors or weapons opens similar possibilities. Data on levels of radiation dose an average American encounters from the important contributing sources are reviewed. The impact, or absence thereof, that a long operating nuclear complex has had on the Hanford Reservation environment is discussed. (auth)

12913 (BNWL-tr-120) ACTION THRESHOLDS AND HEALTH PHYSICS (RADIATION PROTECTION). Delpla, M.; Vignes, S. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1974. Translation of Paper SM-184/21. (CONF-740529-5). 15p. Dep. NTIS $4.00.

From seminar on radiological safety evaluation of population doses and application of radiological safety standards to man and the environment; Portoroz, Yugoslavia (20 May 1974).

Data on radiation dose response relationships in a number of biological systems are reviewed and the rationale of using experimental data rather than mathematical models for establishing radiation protection standards for personnel and the general human population is discussed. The impact of the nuclear power industry on radiation protection recommendations of the ICRP is considered. (CH)

12914 (BNWL-tr-123) INDIVIDUAL AND COLLECTIVE DOSE IN LIGHT OF CIPR RECOMMENDATIONS. Jammett, H.; Mechali, D. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1974. Translation of Paper SM-184/30. (CONF-740529-6). 8p. Dep. NTIS $4.00.

From seminar on radiological safety evaluation of population doses and application of radiological safety standards to man and the environment; Portoroz, Yugoslavia (20 May 1974).

Radiation protection in activities implying exposure to radiation must take into account considerations relative to individuals and considerations relative to the entire human population. The notions of individual dose and collective dose respond to these two aspects, the first making it possible to limit the risks which might be run by individuals to an acceptable value, the second making it possible to estimate the load these activities could impose on society. The studies relative to a practical application of the collective dose concept must be continued and developed. (auth)

12915 (EUR-5122(Vol.1), pp 545-583) CHROMOSOME ABERRATIONS AND MICRODOSIMETRY. Brenot, J. (CEN, Fontenay aux Roses, France); Chemtob, M.; Chmelevsky, D. Mar 1974.

From fourth symposium on microdosimetry; Verbania, Italy (24 Sep 1973).

Studies on chromosome aberration of human lymphocytes (46 chromosomes) and of swine lymphocytes (38 chromosomes) were made with ^{60}Co radiation and different mixed or neutron radiations. The dose-effect relations were statistically established by determining the model best adapted to the experimental data. The microdosimetric parameters were calculated from the experimental measurements made with tissue-equivalent proportional counters simulating different target sizes. The relations between biological results and microdosimetric parameters are discussed. (tr-auth)

12916 CHOLINESTERASE ACTIVITY OF RED BLOOD CELL STROMATA IN MINERS WORKING IN DEEP URANIUM MINES. Pehr, F.; Nosek, J. Cas. Lek. Cesk.; 112: No. 51, 1579-1582 (21 Dec 1973). (In Czech).

The acetylcholine-acetylhydrolase activity (E.C. 3.1.1.7) of the red blood cell stromata in the blood of miners working in deep uranium mines was measured. For this purpose they modified Michel's electrometric method. The authors found significant intense and continuous decrease in cholinesterase activity of the red blood cell-stromata of miners dependent on the duration of their professional exposure and in comparison with a control group. Regression of cholinesterase activity in the red blood cell stromata of the miners' blood depended on the number of years of the professional work and exhibited a regression curve very close to a hyperbola. The maximum of decrease takes place up to 5 years of professional exposure. Biological significance of this phenomenon has been discussed. (auth)

12917 SERUM SEROMUCOID LEVELS IN PATIENTS WITH NEOPLASMS AND IN CASES OF RADIATION-INDUCED NECROSIS FOLLOWING NON-SPECIFIC STIMULATION WITH ZYMOSAN. Dobrek, Z.; Majewski, S.; Maciejewski, B. (Instytut Onkologii, Gliwice, Poland). Pol. Tyg. Lek.; 28: No. 48, 1886-1889(26 Nov 1973). (In Polish).

Serum seromucoid levels were determined in 44 patients before and after stimulation with zymosan. The patients were divided into 3 groups: group I (control) comprised 31 blood donors, group II patients with neoplasms, group III patients with necrosis developing after radiotherapy for neoplasms. The serum seromucoid level was determined by the method of Winzler. A significant decrease of the seromucoid level was found in the group of patients with neoplasms (19 cases) in whom a clinical improvement was observed and in the group of cured necroses (13 cases). On the other hand, in the group of neoplasms without clinical improvement and in the group of necroses without improvement (5 cases) the seromucoid level increased despite stimulation. Determination of seromucoid level in cases of neoplasms and in radiation-induced necrosis may reflect to some extent the dynamics of the disease process and stimulation effect. (auth)

12918 INHALATION OF ADRENOCORTICAL HORMONE (He III) AS A PREVENTION AGAINST RADIATION HAZARDS. Nakagawa, E.; Matsuura, K.; Hayabuchi, N. (Kyushu Univ., Fukuoka). Rinsho To Kenkyu; 50: No. 12, 3653-3656(Dec 1973). (In Japanese).

Inhalation of adrenocortical hormone (He 111) was done in 8 cases with lung cancer and 4 cases with mediastinal tumor who had received radiation therapy; 200 rads of telecocsalt per day were irradiated every two days, and more than 5000 rads were irradiated. The same method by irradiation was done in 18 cases of lung cancer as controls. He 111 had dexamethasone-21-isonicoticic acid ester as main component and is aerosol of the quantitative spraying; 0.125 mg of He 111 is discharged in one spraying. Disturbance of the pulmonary function was seen in all controls. The disturbance of the pulmonary function was seen in 4 of 12 cases (33%) with He 111 and 9 of 18 cases (50%) as controls, at the time of more than three months until irradiation therapy was finished. In addition, the lung was disturbed within a month in control cases, and after 2 months in cases treated with He 111. After 6 months of irradiation, the lung was disturbed in 13 of 14 cases (93%) as controls, and 4 of 6 cases (67%) with administration of He 111. As a result, He 111 was effective for cases with lung cancer and tumor of the mediastinum as protection against radiation hazards. However, it was possible for He 111 to produce infection. (JA)

12919 THERAPY OF RADIATION-INDUCED PROCTITIS BY MEANS OF SALICYLAZOSULFAPYRIDINE. Schulte, W. A. Homburg, Ger.; Univ. des Saarlandes (1972). 36p. (In German).

Thesis.

In a high percentage of the cases of gynecological carcinoma treated with radiotherapy, early and delayed rectal reactions are observed ranging from reactions of the mucous membrane to fistulation. The intensity of the complaints stated by the patients calls for appropriate therapeutic measures although these can only help to alleviate the symptoms. The therapy described here, involving oral or local and, predominantly, combined oral and local administration of salicylazosulfapyridine, proved to be successful in almost 90% of the cases (n = 60), leading to an improvement in the patient's condition or even to a disappearance of symptoms. Hence this therapy is considered to represent a further helpful means of treating radiation-induced proctitis. (GE)

12920 RADIATION AND AGING. Okada, S. (Tokyo Univ.). Tokyo Igaku Zasshi; 81: No. 5, 376-384(Nov 1973). (In Japanese).

The non-specific life-shortening due to radiation was described in 52 references. It is characterized by the following facts. 1) The Gompertz survival curve moves to shorter lives in parallel in the irradiated group. The mean life is shorter the greater the dose of radiation. The life shortening per 100 rads is 15–20 days in young mature mice, about 2.4 to 6.1% of the mean life. In the case of humans, the mean life of radiologists is shorter by about 5 years than that of physicians of other specialties. 2) The main factor for life-shortening in irradiated mice due to radiation is said to be non-specific aging since etiologies in non-irradiated mice all occur early. 3) Modifying factors for life-shortening by radiation are chemical factors (oxygen, SH protective), physical factors (partial irradiation, low-dose irradiation, and divided irradiations, and neutron rays), and biological factors (age on irradiation and aseptic state). (JA)

12921 INFLUENCE OF ETHONIUM ON THE HEALING OF RADIATION INJURIES OF CUTANEOUS AND MUCOUS MEMBRANES. Moldovan, V. I. (Chernovtsy Medical Inst., USSR). Med. Radiol.; 19: No. 6, 37-41(Jun 1974). (In Russian).

Ethonium was used for treating radiation injuries of cutaneous and mucous membranes that had developed after radiation therapy of newgrowths. Treatment was conducted in connection with late radiation ulcers (14 patients), radiation ulcerations of postoperative scars (17 patients), wet epidermites (42 patients), radiation rectites (34 patients), injuries of the lower lip (12 patients), radiation cystites (8 patients), radiation vaginites, and necroses of the cervix uteri mucous membrane (6 patients). Ethonium used in different drugs reduces the time of healing such injuries by 2 to 2.5 times. Complications and contraindications to the application of the preparation were not noted. (auth)

12922 CLINICO-MORPHOLOGICAL CHARACTERISTICS OF LATE RADIATION ULCERS OF THE SKIN. Bardychev, M. S.; Shiukashvili, N. N. (Scientific-Research Inst. of Medical Radiology, Obninsk, USSR). Med. Radiol.; 19: No. 6, 32-37(Jun 1974). (In Russian).

Clinical and morphological data on 120 patients with late radiation ulcers of the skin are considered. Morphological changes were less marked in patients in whom radiation ulcers developed after short focal roentgenological therapy than in patients after remote roentgeno and gamma-therapy. It was concluded that the peculiarities of morphological changes, as well as of those of the regional blood- and lymphocirculation should be taken into consideration when choosing the tactics of treating patients with late lesions of the skin. (auth)

12923 RADIATION FIBROMATOSES AND FIBROSARCOMAS. Pereslegin, I. A.; Galil-Ogly, G. A.; Poroshin, K. K.; Ustinova, V. F.; Blinov, V. M. (Moscow Scientific-Research Rentgeno-Radiological Inst.). Med. Radiol.; 19: No. 6, 25-32(Jun 1974). (In Russian).

Clinico-morphological data are presented concerning two patients with radiation fibrosarcoma, four with pseudosarcomatous radiation fibromatosis, and four with atypical fibroxantoma of the skin. In one patient, fibrosarcoma developed in the anterior abdominal wall 13 years following the operation made after a combined radiation therapy of planocellular keratosic cancer of the cervix uteri; in another patient fibrosarcoma was observed in the soft tissues of the lower leg 16 years after roentgenotherapy of Young's sarcoma which had been clinico-roentgenologically diagnosed. Pseudosarcomatous radiation fibromatosis was found many years after the irradiation of different malignant tumors, which had been confirmed histologically. Atypical fibroxantoma of the skin developed 8 to 12 years after a short-distant roentgenotherapy of basalyomas. On the basis of clinico-morphological data the authors present the differential diagnosis of the above mentioned forms of radiation reaction of the elements of the connective tissue. (auth)

12924 RADIATION INJURY OF THE BONES IN MEGAVOLT THERAPY OF PULMONARY CARCINOMA. Shimanovskaya, K. B.; Strashinin, A. I.; Dyatlova, N. N.; Grigor'eva, Ya. V.; Gladinova, T. S. (Central Scientific-Rentgeno-Radiological Inst., Moscow). Med. Radiol.; 19: No. 6, 16-20(Jun 1974). (In Russian).

In the development of radiation injury of the chest bones in megavolt of pulmonary carcinoma, the volume of the dose of ionizing radiation, quantity of the used fields of irradiation, and the patents' age are of great importance. Radiation injuries of the chest bones were revealed in 11 out of 238 patients (4.6 per cent), in 10 patients injury of ribs developed, in 1 patient an injury of the spine. The maximum focal dose having caused radiation injuries of the bones was 5000 rad. (auth)

12925 SOME RECENT DEVELOPMENT IN CHROMOSOME DOSIMETRY. Lloyd, D. C. Radiol. Prot. Bull.; No. 7, 11-14 (Apr 1974).

Chromosome aberration studies have been initiated in peripheral blood lymphocytes for seminoma patients treated with x- or γ-radiation. With the good prognosis associated with this treatment, the decrease in aberrations may be followed over many years. In general, the distribution of aberrations was non-Poisson, as to be expected from localized partial body exposure. Studies have also been carried out on human blood in a tissue equivalent phantom at various positions on the energy profile of a negative π meson beam. In samples receiving doses of 50 to 500 rads measured at the peak, for aberration levels, the yield was independent over a range of 20 to 70 rads/hour. The results of fractionated irradiation experiments (2 fractions of 100 rads separated by various time intervals) reflected the greater capacity for chromosome repair in cells exposed to lower LET radiation in the plateau. At 24 hours, the peak to plateau ratio was 5.4. It is suggested that aberration yields are a useful method of bioassay for monitoring the damage profile of a pion beam. (UK)

12926 ACCIDENTAL RADIATION EXPOSURE OF TWO INDUSTRIAL RADIOGRAPHERS. Learning the Lesson. Jardine, G. C.; Harrison, N. T. (National Radiological Protection Board, Glasgow). Radiol. Prot. Bull.; No. 7, 20-22(Apr 1974).

An incident is described in which accidental exposure occurred in a confined area where more than one radiation source was being used for industrial radiography. Two teams were simultaneously but independently involved in x radiography and Team 2 accidentally connected the HT cables of the control panels of Team 1. An immediate reconstruction of the exposure predicted that the film dosemeters would have accumulated 3.5 and 2.0 rads, compared with the actual records of 3.9 and 1.8 rads in water. Calculations and measurements yielded average whole body doses of 11.3 and 3.8 rads in tissue, and maximum skin doses calculated were 115 and 28 rads. A number of general recommendations are made to avoid similar occurrence of such incidents, should it not be possible to operate in entirely separate units. (UK)

12927 RADIATION THERAPY OF THYMOMAS COMBINED WITH MYASTHENIA. Kuzin, M. I.; Volkov, B. P. (Moscow Medical Inst.). Sov. Med.; No. 10, 72-77(Oct 1973). (In Russian).

From complications of radiation therapy (in addition to the time deterioration of the myasthenic status) the appearance of focal pneumofibrosis was observed in only one patient. Schlerotic changes of the cellular tissue of the anterior mediastinum and sternum were observed in some of the patients after radiation therapy. (tr-auth)

12928 CHROMOSOME ABERRATIONS IN LYMPHOCYTES AS A BIOLOGICAL INDICATOR OF RADIATION WHICH TAKES INTO ACCOUNT THE DOSE-EFFECT CURVE UNDER IN-VITRO RADIATION CONDITIONS. Liniecki, J.; Bajerska, A. (Polska Akademia Nauk, Warsaw). Artif. Satell.; 8: 111-134(Nov 1973). (In Russian).

From symposium on cosmic biology and medicine; Warsaw, Poland (12 Jun 1972).

Papers dealing with the effects of radiation exposures on chromosome aberrations are reviewed with particular attention to such aberrations in peripheral lymphocytes as a measure of radiation damage. Parameters of lymphocytes radiation damage determined in vitro and in vivo are compared and curves of radiation damage vs radiation doses are discussed. Further studies in this direction under strictly controlled conditions are urged for the development of more advanced radiation damage simulation techniques. (IAA)

12929 PATHOPHYSIOLOGICAL INDICATIONS FOR SEARCH OF NEW PROPHYLACTIC AND THERAPEUTIC METHODS FOR RADIATION SICKNESS AND THE RADIATION SAFETY PROBLEMS OF SPACE FLIGHT. Rogozkin, V. (Polska Akademia Nauk, Warsaw). Artif. Satell.; 8: 135-150(Nov 1973). (In Russian).

From symposium on cosmic biology and medicine; Warsaw, Poland (12 Jun 1972).

Papers dealing with prophylaxis and therapy of radiation sickness are reviewed. Particular attention is given to the effectiveness of available radioprotectors, to the testing of new radiation protection techniques, to radiation simulation models for brief and extended space flights, and to the pharmocology and tolerance characteristics of chemical and biological means of protection in extermal radiation conditions. (IAA)

12930 NEPHRITIS IN TWO CHILDREN AFTER IRRADIATION AND CHEMOTHERAPY FOR NEPHROBLASTOMA. Arneil, G. C.; Harris, F.; Emmanuel, I. G.; Young, D. G.; Flatman, G. E.; Zachary, R. B. (Glasgow Univ.). Lancet; 1: No. 7864, 960-963 (18 May 1974).

In two children subsequent to a 1971 nephrectomy for nephroblastoma, the single remaining kidney was given irradiation of 1500 and 2000 rad, preceded by chemotherapy with antinomycin

D and associated with vincristine therapy. Both children developed a radiation type of nephritis but have survived so far. It is suggested that the use of these two chemotherapeutic agents may increase the risk of radiation damage to the kidney of the child. (auth)

12931 RADIOTHERAPY AND CHROMOSOME ABERRATION. Tamura, H.; Sugiyama, Y. (National Hospital of Kyoto). Sanfujinka Chiryo; 27: No. 6, 666-671(Dec 1973). (In Japanese).

Based on the reports in a period 1960 to 1973, the principal information on chromosome aberration due to radiotherapy up to present was outlined. In order to observe changes in the anomaly during radiotherapy, changes of chromosome aberration of peripheral lymphocytes in patients with uterine cancer were observed. The frequency of cells endowed with labile chromosome aberration increased with the number of irradiation in the first therapeutic week, little changes in the 2nd week, and increased again on and after the 3rd week. The peripheral lymphocyte count decreased rapidly after institution of treatment, and, after a transient plateau, decreased again. Investigated in relation to changes of anomaly after radiotherapy were the reports on long-term survival of cells with chromosome aberration observed in cases of ankylosing spondylitis and uterine cancer. As for chemical radiation protectives for the prevention of radiation injury, the authors' studies of glutathione in vitro and the studies by Tanaka of adronochrome monoguanylhydrazone methansulfonate and MPG in cases of uterine cancer were introduced in relation to the determination of the effect of protectives with chromosome aberration as an indicator. For chromosome aberration due to anticancer agents, the authors observed patients with malignant tumor administered with bleomycin. Different from radiotherapy, the frequency of anomaly tended to decrease even if the medication was continued, after a certain number of administrations. (JA)

12932 SYNERGISTIC EFFECT OF X-RAY AND UV IRRADIATION IN THE FREQUENCY OF CHROMOSOME BREAKAGE IN HUMAN LYMPHOCYTES. Holmerg, M.; Jonasson, J. (Research Inst. of National Defense, Stockholm, Sweden). Mutat. Res.; 23: No. 2, 213-221(May 1974).

Human lymphocytes in the G_1 stage were irradiated with uv light and x rays. A 2-fold increase in the yield of dicentrics was observed in comparison with the yield for x rays alone. This synergistic effect was constant irrespective of the variation in the uv dose between 50 and 100 erg/mm^2. The individual chromosomes participated in interchange aberrations as expected from a random distribution per mitotic chromosome length unit. This observation is in contrast with the recent finding that x-ray-induced chromosome-type breakage is preferentially located on chromosomes with relatively large amounts of R-bands. Thus, the present data indicate that the additional breakage points, due to the synergism, had a different distribution between chromosomes from those induced by x irradiation alone. Mechanisms that could account for the synergistic reaction are discussed. (auth)

12933 HANDBOOK OF LABORATORY SAFETY. Second Edition. Steere, N. V. (ed.). Handbook Series. Cleveland; Chemical Rubber Company (1971). 869p. $26.00.

The purpose of the handbook is to provide convenient information for hazard recognition and control. Specific information is presented under the following general headings: general information; protective equipment; ventilation; fire hazards; chemical reactions; toxic hazards; radiation hazards; electrical and mechanical hazards; water supply; biological hazards; laboratory design and equipment; and tables of chemical hazard information. (ERB)

12934 FLUOROSCOPIC DOSE REDUCTION BY SCANNING X-RAY BEAMS. De Friess, F. B. (Univ. of North Carolina, Chapel Hill). pp 381 of Proceedings of the 26th Annual Conference on Engineering in Medicine and Biology. Vol. 15. Arlington, VA; Alliance for Engineering in Medicine and Biology (1973).

From 26th conference on engineering in medicine and biology; Minneapolis, Minnesota, USA (30 Sep 1973). See CONF-730974-.

A system has been developed to limit the radiation during fluoroscopy to approximately the area that is scanned by the electron beam in the TV camera. A rotating shutter was constructed and adapted to a standard x-ray tube that would give a dose reduction by a factor of 10 while doing fluoroscopy. (ERB)

12935 DNA REPAIR INHIBITION: A NEW MECHANISM OF ACTION OF STEROIDS WITH POSSIBLE IMPLICATIONS FOR TUMOR THERAPY. Gaudin, D.; Guthrie, L.; Yielding, K. L. (Univ. of Alabama, Birmingham). Proc. Soc. Exp. Biol. Med.; 146: No. 2, 401-405(Jun 1974).

A number of steroids were demonstrated to be inhibitors of DNA repair replication in normal human lymphocytes. This inhibitory capability is a previously unrecognized mechanism of action of these compounds. Because the alkylating agents and x-rays used in tumor therapy cause chemical alterations to cellular DNA of a type that can be repaired by the excision repair process, it is suggested that repair inhibitory steroids may be useful in conjunction with treatment involving alkylating agents or x-rays. (auth)

12936 AEROSPACE MEDICAL ASSOCIATION PREPRINTS OF PAPERS PRESENTED AT ANNUAL SCIENTIFIC MEETING, LAS VEGAS, NEVADA, MAY 7-10, 1973. Washington, DC; Aerospace Medical Association (1973). 316p. (CONF-730590-).

From Aerospace Medical Association symposium; Las Vegas, Nevada, USA (7 May 1973).

A separate abstract was prepared for one paper. Three hundred additional papers discuss various aspects of stress physiology relevant to space flight. (CH)

For an abstract of an individual paper see: 12937.

12937 CHANGES IN SERUM CREATING PHOSPHOKINASE (SCPK) LEVELS AFTER TOTAL-BODY IRRADIATION IN MAN. Ricks, R. C.; Lushbaugh, C. C. (Oak Ridge Associated Universities, TN). pp 176-177 of Aerospace Medical Association Preprints of Papers Presented at Annual Scientific Meeting. Washington, DC; Aerospace Medical Association (1973).

From Aerospace Medical Association symposium; Las Vegas, Nevada, USA (7 May 1973). See CONF-730590-.

Normal volunteers and leukemia patients undergoing total-body therapeutic γ irradiation exercised under controlled conditions on a bicycle ergometer. A radiation accident victim also exercised on a regular basis for about 6 weeks postirradiation. The exercise workloads used were of moderate intensity (245 to 612 kpm/min). Serum samples were obtained via venapuncture prior to each exercise period and several times weekly from irradiated patients who were not subjected to controlled exercise stress. Serum creatine phosphokinase levels in four normal male volunteers subjected to two or three controlled exercise periods per week over a one-month period are compared with those in exercising and nonexercising leukemic patients exposed to protracted (30 R/20 h day) and fractionated (10 R/day at 1.5 R/h) irradiation therapy. Exercise-stressed patients responded as if ergometric stress had been applied but the radiobiological mechanism for this diminished exercise capacity and for changes in serum creatine phosphokinase levels was not determined. (CH)

12938 HAZARD OF ACUTE RADIATION PNEUMONITIS IN CHILDREN RECEIVING MEDIASTINAL RADIATION. Littman, P. (Univ. of Pennsylvania, Philadelphia); Davis, L. W.; Nash, J.; Tefft, M.; Borns, P.; Lepanto, P. Cancer; 33: No. 6, 1520-1525 (Jun 1974).

Two children are described who developed fatal pneumonitis after receiving what is considered to be an acceptable dose of irradiation to the whole thorax, plus additional radiotherapy to the mediastinum. It was concluded that irradiation to the whole thorax with addition of further radiotherapy to the mediastinum is likely to cause severe acute radiation pneumonitis. The use of concomitant chemotherapy may accentuate the hazard. (auth)

12939 LUNG CANCER AT AUTOPSY IN A-BOMB SURVIVORS AND CONTROLS, HIROSHIMA AND NAGASAKI, 1961-1970. Cihak, R. W. (Atomic Bomb Casualty Commission, Hiroshima); Ishimaru, T.; Steer, A.; Yamada, A. Cancer; 33: No. 6, 1580-1588 (Jun 1974).

Previous studies indicated there was a probable increase of lung cancer in atom bomb survivors in Hiroshima and Nagasaki. In reexamination of this problem, lung cancer was found in 204 of 3778 autopsies on radiation exposed survivors and controls performed during 1961 to 1970. Using the W.H.O. classification, 32% were epidermoid, 19% small cell anaplastic, 29% bronchogenic adenocarcinoma, 9% bronchiolo-alveolar, and 11% other types of carcinoma. Small cell anaplastic carcinomas were definitely increased in irradiated persons compared to controls (relative risk 3.9; $p < 0.5$). Epidermoid and bronchogenic adenocarcinoma showed increased risk, but this was not statistically significant. In this entire series, 89% were 60 years old or older; 67% were in men with male : female ratios of 2.4 : 1 for epidermoid, 2.9 : 1 for small cell anaplastic, and 1.3 : 1 for bronchogenic adenocarcinoma. No data were available for a study of the possible effect of internal irradiation. An analysis of the effect of smoking and occupation on the interpretation of single dose whole body ionizing irradiation as a cause of lung cancer will be reported separately. (auth)

12940 MALIGNANT AND BENIGN NEOPLASMS OF THE THYROID IN PATIENTS TREATED FOR HYPERTHYROIDISM: A REPORT OF THE COOPERATIVE THYROTOXICOSIS THERAPY FOLLOW-UP STUDY. Dobyns, B. M.; Sheline, G. E.; Workman,

J. B.; Tompkins, E. A.; McConahey, W. A.; Becker, D. V. (Cleveland Metropolitan General Hospital). J. Clin. Endocrinol. Metab.; 38: No. 6, 976-998(Jun 1974).

Data concerning the occurrence of malignant and benign thyroid neoplasms in patients treated for hyperthyroidism have been collected at 26 medical centers in the Cooperative Thyrotoxicosis Therapy Follow-up Study. There was 98.8% follow-up in 36,050 patients treated for hyperthyroidism between 1946 and 1968. The analysis is based on 34,684 patients treated by ^{131}I, thyroidectomy, antithyroid drugs, X-irradiation or various combinations of these therapeutic measures. Cases were classified as: Graves' disease without palpable nodules, Graves' disease with palpable nodules, toxic adenoma(s) or unclassified types. The interval of time for the occurrence of a neoplasm (identified by removal) was classified as occurring either at the time of or within 1 year of initial therapy or at sometime greater than 1 yr following therapy. There were 86 malignant thyroid neoplasms found among 34,684 patients. Of those few malignant neoplasms found in Graves' disease, many were of the occult variety, the clinical potential of which is unknown. There were 9 malignant thyroid neoplasms found within 1 yr of treatment in 21,714 patients treated by ^{131}I, 50 in 11,732 patients treated by thyroidectomy, and none in 1,238 patients treated with antithyroid drugs. After an interval of more than 1 yr there were 19 malignant thyroid neoplasms following ^{131}I, 4 following thyroidectomy, and 4 following antithyroid therapy in these respective populations. If the occurrence of 19 malignant lesions found 1 yr or more after ^{131}I is viewed from the standpoint of the incidental malignant lesions found in patients treated primarily by thyroidectomy, the risk from ^{131}I is not significant. There were five anaplastic carcinomas found more than 1 yr following ^{131}I therapy and one fibrosarcoma following thyroidectomy plus ^{131}I therapy. The anaplastic neoplasms occurred within 5 yr of therapy and in patients with an average age of 69.4 yr. No anaplastic lesions were found within 1 yr of any treatment. There were four deaths from malignant thyroid neoplasms among 11,732 patients treated by thyroidectomy, six deaths from malignant neoplams in 21,704 patients treated with ^{131}I, and no deaths from malignant lesions in 1,238 patients treated more than 1 yr with antithyroid drugs. The occurrence of thyroid adenomas is higher when ^{131}I therapy is used for treatment in the first two decades of life than when used in older individuals. (auth)

Vertebrates

Refer also to abstracts 12710 and 12869.

12941 (AEC-tr-7548) RADIOBIOLOGY. Translated from Radiobiologiya; 14: No. 1, 3-160(1974). 202p. Dep. NTIS $7.60.

Separate abstracts were prepared for the 38 papers presented in this issue.

For abstracts of individual papers see: 12846, 12847, 12857-12861, 12880, 12881, 12901-12904, 12911, 12942-12960, 13000, 13010-13012, and 13017.

12942 (AEC-tr-7548, pp 1-6) RADIOSENSITIVITY OF THE PROCESS OF REPLICATION OF NUCLEAR DNA OF RAT ASCITIC HEPATOMA. Komar, V. E.; Nikitina, Z. S.; Shutko, A. N. (Central Scientific Research Roentgenoradiological Inst., Leningrad). 1974. Translated from Radiobiologiya; 14: No. 1, 3-7(1974).

The replication of the DNA of Seidel's ascitic hepatoma occurs through a step of formation of a rapidly sedimenting complex (RSC), possibly with the participation of the components of the nuclear membrane. The irradiation of ascites cells in vivo at doses of 1500 and 5000 rad retards the formation of the RSC, and to a lesser degree influences the formation of low-molecular fragments of the new-formed DNA and an incorporation into the long chains of chromosomal DNA. It was concluded that the reaction to irradiation of different forms of structural organization of the replicating DNA in the nuclei of cells of higher organisms differs. (tr-auth)

12943 (AEC-tr-7548, pp 24-29) ACTIVITY OF TOTAL AND FREE ACID PHOSPHATASE IN THE ORGANS OF RATS AFTER IRRADIATION. Bicheikina, N. I.; Romantsev, E. F. (Inst. of Biophysics, Moscow). 1974. Translated from Radiobiologiya; 14: No. 1, 21-25(1974).

The free and total activity of acid phosphatase in the liver, brain, spleen, and thymus of rats was investigated after a single γ irradiation at a dose of 900 R. A two-phase increase in the activity of acid phosphatase of the lymphoid organs (spleen, thymus) was detected. The enzymatic activity in the brain is increased during the first 15 min, and in the liver 2 hrs after irradiation, but then progressively decreases. The question of the individual radiosensitivity of isoenzymes of acid phosphatase is discussed. (tr-auth)

12944 (AEC-tr-7548, pp 30-34) BEHAVIOR OF 2-AMINO-Δ^2-THIAZOLINE AND 2-AMINO-Δ^2-DIHYDRO-1, 3-THIAZINE IN THE MAMMALIAN ORGANISM. Mandrugin, A. A.; Tarasenko, A. G.; Fedoseev, V. M.; Gintsburg, E. I.; Nekrasova, I. V. (Moscow State Univ.). 1974. Translated from Radiobiologiya; 14: No. 1, 26-29(1974).

The behavior of 2-amino-Δ^2-thiazoline (2-AT) and 2-amino-Δ^2-dihydro-1, 3-thiazine (2-ADT) in the organs and tissues of mice was studied by the method of paper radiochromatography. It was shown that 2-AT and 2-ADT are extremely stable in the organism and are not converted to the corresponding mercaptoalkylureas. In view of the fact that 2-AT and 2-ADT are accumulated in the organs and tissues of animals after they are administered S-(2-aminoethyl)-thiuronium and S-(3-aminopropyl)-thiuronium in significantly greater amounts than after the introduction of 2-AT and 2-ADT, it was concluded that aminoalkylthiuronium compounds are a unique transport form of the corresponding heterocycles in the animal organism. (tr-auth)

12945 (AEC-tr-7548, pp 35-40) RADIATION ANOMALIES OF CAT HEMOGLOBIN. Sukhomlinov, B. F.; Kashchenko, V. E. (Lvov State Univ.). 1974. Translated from Radiobiologiya; 14: No. 1, 30-34(1974).

The physicochemical properties and partial chemical structure of hemoglobin of cats irradiated at a dose of 1000 R were investigated. Preparative isolation of a supplementary fraction, specific for radiation pathology, was performed by column chromatography on G50 CM-cellulose. The results of amino acid and dactylographic analyses of this fraction indicate a difference of the chemical structure of hemoglobin from the remaining heme fractions obtained from hemolyzates of cat erythrocytes. The detection of supplementary peptides on the dactylograms of tryptic hydrolyzates of the specific fraction of the irradiated animals is characteristic of hemoglobin synthesized de novo, which is one of the basic criteria of the vulnerability of its protein-synthesizing system. (tr-auth)

12946 (AEC-tr-7548, pp 41-45) ANTIOXIDANT ACTIVITY OF LIPIDS AND RADIOSENSITIVITY. Communication 1. Seasonal Changes in the Antioxidant Activity of Liquids and the Radiosensitivity of Mice. Shishkina, L. N.; Burlakova, E. B.; Dzyuba, N. M.; Gaintseva, V. D.; Molochkina, E. M.; Pal'mina, N. P. (Inst. of Chemical Physics, Moscow). 1974. Translated from Radiobiologiya; 14: No. 1, 35-38(1974).

The change in the antioxidant activity of the lipids of the liver and spleen of mice of different lines at different times of the year was studied with the aid of the methyl oleate oxidative model. Seasonal fluctuations in the average lifetime of mice of the BALB line, irradiated at a dose of 650 R, were detected. A comparison of the experimental data obtained showed that the resistance of the animals to irradiation is correlated chiefly with the change in the antioxidant activity of the spleen lipids. (tr-auth)

12947 (AEC-tr-7548, pp 46-51) DYNAMICS OF THE ACCUMULATION OF LIPID PIGMENTS IN THE TISSUES OF ANIMALS UNDER CERTAIN INFLUENCES. Vertushkov, V. T.; Ivanov, I. I. (Moscow State Univ.). 1974. Translated from Radiobiologiya; 14: No. 1, 39-43(1974).

It was shown that together with the action of ionizing radiation, intraperitoneal injection of adrenalin, aminoethylisothiuronium (AET), cystamine, reduced glutathione, and other radioprotectors also leads to the formation of lipid pigments in the tissues of mice. The colored fraction isolated from the lipids of the spleen after the administration of AET to mice in an amount of 150 mg/kg contains polymers with a maximum molecular weight more than 4000. Lipid pigments also appear in the tissues of mice after intraperitoneal injection of oleic acid. The kinetics of the accumulation of pigments in the tissues of animals depends on the dose of irradiation, the radioprotector introduced, and the concentration of peroxides in the oleic acid introduced. (tr-auth)

12948 (AEC-tr-7548, pp 52-57) INFLUENCE OF TAURINE ON THE RESTORATION OF TISSUE RESPIRATION AND OXIDATIVE PHOSPHORYLATION IN THE LIVER MITOCHONDRIA OF IRRADIATED RATS. Dokshina, G. A.; Yartsev, E. I.; Kolesnikov, Yu. A.; Kostesha, N. Ya. (Tomsk Univ., USSR). 1974. Translated from Radiobiologiya; 14: No. 1, 44-48(1974).

The influence of taurine and its potassium phosphate salt on the tissue respiration, respiratory control, and oxidative phosphorylation in the liver mitochondira of rats irradiated with γ quanta of high-energy radiation from the betatron (31 MeV) at a dose of 700 rad was investigated. An early therapeutic effect from the administration of the preparation (200 mg/kg) was established 2, 4, 6, and 8 days after irradiation. (tr-auth)

12949 (AEC-tr-7548, pp 58-63) INFLUENCE OF CERTAIN BIOLOGICALLY ACTIVE PREPARATIONS ON A POPULATION

OF CELLS OF THE STEM FRACTION OF HEMATOGENESIS AND THE SURVIVAL OF IRRADIATED MICE. Communication 1. Polyanions. Konoplyannikov, A. G.; Konoplyannikova, O. V.; Semina, O. V.; Poverennyi, A. M. (Scientific Research Inst. of Medical Radiology, Obninsk, USSR). 1974. Translated from Radiobiologiya; 14: No. 1, 49-52(1974).

The administration of natural and synthetic polyanions to CBA and noninbred mice two days before irradiation leads to an increase in the yield of spleen endocolonies and exocolonies after transplantation of bone marrow from isologous donors. The observed effects are evidently associated with the influence of polyanions on processes of fixation of cells of the stem fraction of hematogenesis in the spleen of the animal. In the case of a single whole-body irradiation, polyvinyl sulfate does not influence the survival of the mice. (tr-auth)

12950 (AEC-tr-7548, pp 96-102) ROLE OF ENDOGENOUS SUBSTANCES IN THE ACTION OF A BACKGROUND OF INCREASED RADIORESISTANCE. Communication 3. Role of Endogenous Serotonin. Sobolev, A. S.; Zhamsaranova, S. D.; Orekhov, A. N.; Goncharenko, E. N.; Kudryashov, Yu. B. (Moscow State Univ.). 1974. Translated from Radiobiologiya; 14: No. 1, 78-82(1974).

Lysergic acid diethylamide prevents the accumulation of exogenous serotonin in a perfused rat small intestine. p-Chlorophenylalanine, an inhibitor of one of the enzymes of serotonin formation, tryptophan hydroxylase, induces a substantial drop in the serotonin level in radiosensitive tissues, accompanied by a decrease in the radioresistance of the animals. The role of the serotonin present in the tissues in the radioresistance of animals is discussed. (tr-auth)

12951 (AEC-tr-7548, pp 109-113) DETECTION OF CELLULAR RADIATION AUTOALLERGY IN MICE BY THE METHOD OF INHIBITION OF SPLENOCYTES. Ulanova, A. M. (Inst. of Biophysics, Moscow). 1974. Translated from Radiobiologiya; 14: No. 1, 88-91(1974).

The presence of a hyperegic reaction, which is expressed in a substantial decrease in the migration activity of splenocytes in the presence of tissue antigens of the kidney and intestine, was established in experiments on mice irradiated with the γ rays of ^{60}Co at doses of 250, 400, and 700 R by the method of inhibition of the migration of lymphoid cells. (tr-auth)

12952 (AEC-tr-7548, pp 121-127) HEMOSTIMULATION AS A RADIOPROTECTIVE AGENT IN THE CASE OF PROLONGED IRRADIATION. Klemparskaya, N. N. (Inst. of Biophysics, Moscow). 1974. Translated from Radiobiologiya; 14: No. 1, 97-101(1974).

It was established in experiments on female white mice weighing 18 to 20 g that the subcutaneous injection of 0.1 ml of fresh citrate mouse blood 3 to 5 days before irradiation at a dose of 800 R, dose rate 18.7 R/h, with the γ rays of cesium-137, leads to a significant increase in the survival of the animals. In the experimental groups 87.1% survived in comparison with 54.9% in the controls. When the same amount of blood was injected subcutaneously immediately after the end of irradiation, 66.6% survival was obtained in the experimental groups in comparison with 39.5% in the control. Thus, hemostimulation by the injection of homologous blood has both a prophylactic and a therapeutic effect in the case of prolonged irradiation. (tr-auth)

12953 (AEC-tr-7548, pp 136-138) DYNAMICS OF THE CONTENT OF ADENYLIC NUCLEOTIDES IN THE RAT LIVER IN RADIATION SICKNESS. Savitskii, I. V.; Litovchenko, I. N. (Odessa Medical Inst., USSR). 1974. Translated from Radiobiologiya; 14: No. 1, 108-110(1974).

Data on the influence of penetrating radiation on the content of ATP, ADP, and AMP in various tissues of animals pertain chiefly to the early periods after the radiation influence. Dynamics of the content of adenylic nucleotides in the rat liver at various periods after the radiation influence were studied. (tr-auth)

12954 (AEC-tr-7548, pp 140-143) ROLE OF ENDOGENOUS THIOLS IN CHANGES IN THE NATURAL RADIOSENSITIVITY OF CELLS DURING GROWTH OF EHRLICH'S ASCITES CARCINOMA. Gusareva, E. V. (Inst. of Developmental Biology, Moscow). 1974. Translated from Radiobiologiya; 14: No. 1, 111-114(1974).

The question of the causes of the different radiosensitivity of tumors is one of the basic questions in clinical radiotherapy. There are a number of hypotheses on the nature of the differences in radiosensitivity of biological objects. One of them relates these differences to the level of endogenous thiols. Extensive experimental material on the correlation of the natural radiosensitivity of mammals (individual, line, and age) with the content of thiols in their hematogenic tissue has now been accumulated. Such a correlation has also been established for isolated plant, bacterial, and embryonic cells. All this gives a basis for believing that the changes in radiosensitivity during tumor growth depend definitely on the corresponding changes in the amount of endogenous thiols in the tumor cells. The present work was devoted to an investigation of this question. (tr-auth)

12955 (AEC-tr-7548, pp 144-147) CORRELATION OF THE THIOL LEVEL IN BONE MARROW CELLS WITH AGE CHANGES IN THE RADIOSENSITIVITY OF MICE. Dontsova, G. V.; Smirnova, I. B. (Inst. of Developmental Biology, Moscow). 1974. Translated from Radiobiologiya; 14: No. 1, 114-116(1974).

During postnatal ontogenesis, the sensitivity of animals to ionizing radiation changes substantially. The mechanisms determining these changes have not yet been elucidated. The literature data give evidence of the presence of a direct correlation between the radiosensitivity and the thiol level in biological objects, in particular, in hematogenic tissue, the radiation damage to which causes death of the animals at relatively low doses of irradiation. In these studies the thiol content was determined in tissue homogenates. And yet, it is precisely the state of the hematogenic cells that primarily determines the fate of an irradiated organism. Therefore, in this investigation the radiosensitivity of mice was compared with the content of protein thiols, which constitute the bulk of the endogenous SH compounds, in bone marrow cells. (tr-auth)

12956 (AEC-tr-7548, pp 152-155) RADIOSENSITIVITY OF COLONY-FORMING CELLS IN MICE UNDER SALT LOADING. Pereverzev, A. E. (Inst. of Cytology, Leningrad). 1974. Translated from Radiobiologiya; 14: No. 1, 119-122(1974).

Salt loading was used to influence the repair of hematogenic mouse cells in vivo, a method used in experimental neuroendocrinology in the study of adaptation responses. As a result of salt loading on the organism, the effectiveness of endogenous colony formation is reduced; single and fractionated irradiations have the same influence on the number of colonies in the spleen. The detected effects are reversible if the salt load is removed three days after irradiation. An analysis of the nature of the damages (sublethals or lethals) to hematogenic cells arising against a background of salt loading of mice was studied. In this work we studied the causes of the low level of survival of colony-forming cells in irradiated mice under salt loading. (tr-auth)

12957 (AEC-tr-7548, pp 159-162) UTILIZATION OF THE PRINCIPLE OF STRUCTURAL ANALOGY FOR THE SEARCH FOR SUBSTANCES TO REDUCE THE TOXICITY OF CYSTAMINE. Krasil'nikov, I. I. (Military-Medical Academy, Leningrad). 1974. Translated from Radiobiologiya; 14: No. 1, 125-128(1974).

Certain biological effects of cystamine are determined by its aliphatic α, ω-diamine structure. Like other diamines, cystamine can, for example, liberate histamine from the tissues and react with DNA molecules with its amino groups. Since aliphatic diamines, including sulfur-containing compounds, possess the ability to compete for receptors, it has been suggested that they include substances that weaken the action of cystamine. Among the drug preparations known in this area, a derivative of tetramethylenediamine, isoprin (N, N'-diisopropylputrescine), was tested. (tr-auth)

12958 (AEC-tr-7548, pp 163-165) INFLUENCE OF VASODILATORS ON THE RADIOPROTECTIVE EFFECTIVENESS OF MEXAMINE. Anashkin, O. D.; Shashkov, V. S.; Manaeva, I. A.; Sabaev, V. V.; Karsanova, S. K. 1974. Translated from Radiobiologiya; 14: No. 1, 128-129(1974).

The action of vasodilators, papaverine and aminazine, on the radioprotective effectiveness of 5-methoxytryptamine was investigated. Both preparations lower the protective action of mexamine by 40 to 50% and reduce the average lifetime of mice when administered both separately and jointly. (tr-auth)

12959 (AEC-tr-7548, pp 166-169) MORPHOLOGICAL CHANGES IN THE CRYSTALLINE LENS OF RATS AFTER EXTERNAL BETA IRRADIATION. Milovidova, I. A.; Moskalev, Yu. I.; Grammatikati, V. S. (Inst. of Biophysics, Moscow). 1974. Translated from Radiobiologiya; 14: No. 1, 130-134(1974).

The origin and development of disorders in the crystalline lens after external β irradiation were investigated and histological determination was made of the threshold dose. (ERB)

12960 (AEC-tr-7548, pp 170-172) CHANGE IN THE MYOCARDIUM UNDER THE ACTION OF VARIOUS DOSES OF IRRADIATION AND INFLUENCE OF VITAMIN B_1 ON RECOVERY PROCESSES. Akhmedov, N. K.; Ushakova, E. Ya. (Tashkent State Medical Inst., USSR). 1974. Translated from Radiobiologiya; 14: No. 1, 134-136(1974).

Morphological changes in the cardiac muscle, the intramuscular vessels, and nerve apparatus arising under the influence of x rays, as well as the influence of vitamin B_1 on the course of regeneration processes, were studied. The experiments were conducted on 42 rabbits, which were subjected to irradiation at doses of 300 and 600 R. Individual animals, irradiated at a dose of 300 R, received a subcutaneous injection of vitamin B_1, 0.002 mg per kg of weight, over a period of 45 days. The period of observation was up to one year. The morphological changes and the influence of vitamin B_1 are discussed. (ERB)

12961 (ANL-8070, pp 29-54) RADIATION TOXICITY IN DOGS. Norris, W. P. Dec 1973.

In Division of Biological and Medical Research annual report, 1973.

Progress is reported on studies of the effects of continuous whole-body γ irradiation on beagles. Data are included on the survival and clinical observations on dogs placed in a ^{60}Co γ field with daily exposure rates of 5, 10, 17, or 35 R/22-hr exposure day until death. Septicemia was a primary cause of death and the effects of antibiotic treatment in dogs exposed to 35 R/day was evaluated. The incidence of anemia and myelogenous leukemia in dogs exposed to various dose rates for various periods of time was determined. The rate of antibody production following injection of a bacteriophage was also studied. Pregnant beagles exposed from conception to parturition to dose rates ranging from 5 to 35 R/day delivered normal litters and preliminary data on the reproductive capability of the progeny are included. (CH)

12962 (ANL-8070, pp 55-71) CARCINOGENESIS. Fry, R. J. M. Dec 1973.

In Division of Biological and Medical Research annual report, 1973.

Progress is reported on studies of carcinogenesis in mice and rats. Five areas of investigation included: isozymes in carcinogenesis, hepatic tumorigenesis and the enhancement of chemically induced tumors, strain and species differences in both spontaneous and induced tumor rates, electron microscopic studies, and the effects of skin treatment with psoralen and near ultraviolet light. (CH)

12963 (ANL-8070, pp 81-108) AGING RESEARCH. Sacher, G. A.; Flynn, R. J. Dec 1973.

In Division of Biological and Medical Research annual report, 1973.

The program of the aging research group can be divided into two major subprograms, one of which is concerned with the comparative biology, genetics, and evolutionary biology of aging, and the other with the elucidation of the ontogenetic aging processes in mammals, especially in the cell membrane and the immune system. Data are included from preliminary studies on the relationship between aging and radioinduced life shortening in mammals. (CH)

12964 (COO-2005-8) BIOCHEMICAL ASPECTS OF ERYTHROPOIESIS IN CHRONIC IRRADIATION. Final Report. Brambel, C. E. (Notre Dame Univ., Ind. (USA)). 1 May 1974. Contract AT(11-1)-2005. 11p. Dep. NTIS $4.00.

Spontaneous recovery of splenic erythropoiesis during chronic irradiation of rats results in the elaboration of an altered hemoglobin molecule. Several basic physical criteria characterize this altered hemoglobin. Results of the studies revealed that splenic erythropoiesis was a response to the anemia which developed as a result of the chronic suppression of erythropoiesis. This was shown by producing marked splenic erythropoiesis at earlier times during exposure to irradiation in response to bleeding, hemolysis, or anoxia. (auth)

12965 (COO-3380-13) PROLIFERATION OF EARLY TUMOR FOCI IN IRRADIATED RAT SKIN. Period Covered: August 1, 1973–July 31, 1974. Burns, F. J.; Vanderlaan, M.; Albert, R. E. (New York Univ., N. Y. (USA). Inst. of Environmental Medicine). 1974. Contract AT(11-1)-3380. 22p. (CONF-740715-1). Dep. NTIS $4.25.

From international radiation research congress meeting; Seattle, Washington, USA (14 Jul 1974).

Results are summarized from studies on the growth patterns of radioinduced rat skin tumors. The importance of tumor growth rate on appearance time is stressed. Tumors were induced by using either (Grenz) x rays or electrons at doses ranging from 1000 rads to 5000 rads. Gompertz functions were fit to the growth curves of 153 tumors and values for the initial specific growth rate constant and retardation constant were determined. The distribution of these constants was independent of dose, histological type of tumor, and appearance time. Further studies were conducted on skin tumors in subvisible size range (0.1 mm to 1.0 mm diameter) located by clearing the skin and searching under a dissecting microscope. Tumors were characterized as to proliferation rate, vasculature, location within the skin, and histologic type. The incidence curve for the small lesions showed a consistent displacement about 10 weeks earlier than the comparable curve for visible tumors. Of the lesions small enough to be assigned a location, 62% were in the outermost 0.15 mm of skin while 14% were found at depths exceeding 0.5 mm. (auth)

12966 (EUR-5122(Vol.1), pp 489-518) DETERMINATION OF THE SHAPE OF MAMMALIAN CELL SURVIVAL CURVES BY THE EVALUATION OF CELLULAR RECOVERY AS THE FUNCTION OF THE SIZE OF THE FRACTION. Comparison with Theoretical Models. Wambersie, A.; Dutreix, J.; Gueulette, J. (Tumor Center, Louvain Belg.). Mar 1974.

From fourth symposium on microdosimetry; Verbania, Italy (24 Sep 1973).

Survival curves for different mammalian cell lines have been determined in vivo by cloning techniques on experimental animals. Another approach to the investigation of the shape of cell survival curves in vivo will be presented here from direct observation of gross tissue reactions both on animals and patients. The experimental data provided by split-dose experiments are given. They are expressed in terms of additional recovered dose, i.e. the dose increment necessary to reach a given biological effect when a dose is split into two equal doses. These results lead to practical conclusions for radiotherapy. Some characteristics of the cell survival curves were derived from the variation of the additional recovered dose as a function of the dose per fraction. This requires assumptions which are discussed. (auth)

12967 IMMUNOLOGIC STUDIES ON T AND B LYMPHOCYTES IN CHIMPANZEES: EFFECTS OF THYMECTOMY AND IRRADIATION. Gilbertsen, R. B.; Metzgar, R. S.; Seigler, H. F. (Duke Univ. Medical Center, Durham, NC). Transplant. Proc.; 6: No. 2, 183-188(Jun 1974).

Two chimpanzees were thymectomized and given lethal doses of x radiation. One animal was also splenectomized. Function capacities of T lymphocytes were measured in two ways: in vitro responsiveness to the T-cell mitogens phytohemagglutinin (PHA) and concanavalin A (Con-A) and the ability of T lymphocytes to respond in mixed lymphocyte reactions. Hematological data are presented for periods up to 345 days following irradiation. Total thymectomy and irradiation resulted in a reduction in the levels of circulating T lymphocytes and in impairments in their functions. There was a strong tendency toward hyporesponsiveness to the T-cell mitogens in the thymectomized animal; the responses of the animal that was also splenectomized were normal to high for both mitogens. The data from the mixed lymphocyte reaction studies showed that the chimpanzees had a normal capacity to respond and to stimulate when tested with normal unrelated chimpanzees. (HLW)

12968 BENEFICIAL INFLUENCE OF LIMITED HISTOCOMPATIBILITY OF BONE MARROW GRAFTED TO UNRELATED RHESUS MONKEYS PRECONDITIONED WITH X-RAYS AND ALS. Neefe, J. R. Jr.; Merritt, C. B.; Darrow, C. C. II; Rogentine, G. N. Jr. (National Cancer Inst., Bethesda, MD). Transplant. Proc.; 6: No. 2, 125-128(Jun 1974).

ALS usually eliminates the acute killing effect of allogeneic marrow given rhesus monkeys with x-ray preconditioning alone. In a retrospective analysis, incomplete matching for histocompatibility antigens in a direction favoring the reduction of GvHD was found in many of the longer survivors. When all pools of ALS (antilymphocyte serum) were considered together, the influence of limited matching was statistically significant. A group of eight monkeys was treated with various protocols involving a single new pool of ALS, which itself could not be shown to be different from other pools of ALS. All were partically matched prospectively and all enjoyed improved survival when compared with mismatched controls preconditioned with x-ray and all other pools of ALS. Partial matching for RhL-A antigens confers an advantage upon rhesus monkeys receiving bone-marrow allografts from unrelated donors. (auth)

12969 PULSE CYTOPHOTOMETRIC DETERMINATION OF THE DNA OF NON-IRRADIATED AND X-IRRADIATED THYMUS LYMPHOCYTES OF JUVENILE MICE. Altemeier, W. Muenster, Ger.; Univ. Muenster (1972). 27p. (In German).

Thesis.

Juvenile mice of the inbred strain Han NMRI were exposed to whole-body x irradiation at various low doses (10 to 150 R). The quantitative distribution of the DNA in the thymus lymphocytes of the mice was plotted 6 to 96 h after irradiation by means of pulse cytophotometry. These histograms revealed marked changes in the distribution pattern even for whole-body irradiation with doses of 10 R or 75 R. The relative proportion of the S-phase cells of the generation cycle was found to have disappeared completely

after 24 h following whole-body irradiation, and DNA synthesis of the thymocytes started again only after 48 h following whole-body irradiation. The relative proportion of the G1-phase cells was not reduced significantly in animals irradiated with 10 R. This is assumed to be due to an interphase death of the cells, so that this process that was observed in lymphocytes seems to be present also in thymocytes irradiated with low doses. The distribution pattern recorded after irradiation with 75 R clearly showed a relative decrease in the proportion of S-phase cells, followed by a regeneration of S-phase cells. This indicates that the thymocytes represent a special case in this respect, since no such effect on the DNA distribution was found in other cell groups after irradiation with such low doses. The relatively higher loss of G1-phase cells after irradiation with higher doses also points to the occurrence of interphase death of the thymocytes. In this case too, DNA-synthesis of the cells drops to zero after 24 h and was found to recommence after a latency period of 60 to 72 h. (GE)

12970 PECULIARITIES OF HEMODYNAMIC CHANGES UNDER CONDITIONS OF CONTINUOUS BODY X IRRADIATION AND HEAD-SHIELDING IN RABBITS. Sharashenidze, N. B. (Inst. of Physiology, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR; 74: No. 2, 437-440(May 1974). (In Russian).

In acute experiments with rabbits maintained on artificial respiration, x irradiation of the body at high doses results in sharp changes in the arterial pressure, minute volume, and common peripheral resistance, identical to those occurring in the case of whole-body irradiation. Rather acute decrease occurs in peripheral resistance, followed by a significant rise in minute volume. This latter, however, is not sufficient to maintain a normal level of arterial pressure. When the irradiation total dose is as high as 15 to 20 krads the resistance starts to rise, but the minute volume and blood pressure gradually decrease considerably. (auth)

12971 PECULIARITIES OF HEMATOPOIESIS IN THE MARROW OF HEALTHY AND TUMOROUS RATS DURING LOCAL IRRADIATION. Abakeliya, Ts. I. (Inst. of Experimental and Clinical Surgery, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR; 74: No. 2, 485-488(May 1974). (In Russian).

Suppression of hematopoiesis in the marrow in the process of the action of ionic irradiation of an x-rayed leg of tumorous animals is much more pronounced than is the case in healthy rats. After x-ray therapy, hematopoiesis in an x-rayed leg of a healthy animal occurs faster and to a fuller extent than in tumorous rats. (auth)

12972 ROLE OF T CELLS IN THE PASSIVE TRANSFER OF CONTACT SENSITIVITY AND THEIR OCCURRENCE IN THE BONE MARROW. Zembala, M. (Inst. of Microbiology, Krakow); Asherson, G. L. Eur. J. Immunol.; 3: 667-680(Nov 1973).

Contact sensitivity to 4-ethoxymethylene-2-phenyl oxazolone can be transferred to irradiated recipients by lymph node, spleen, and bone marrow cells from sensitized donors. The transfer by lymph node, spleen, and bone marrow cells was abolished by anti-Θ serum whose specificity was confirmed by absorption with CBA brain. Transfer by peritoneal exudate cells was relatively resistent to treatment with anti-Θ serum. Mice deprived of T cells did not develop contact sensitivity following immunization, and their bone marrow and peritoneal exudate cells failed to transfer contact sensitivity. It was concluded that T cells were required both for the induction and for the passive transfer of contact sensitivity. (auth)

12973 EFFECT OF X IRRADIATION ON THE APPEARANCE OF ANTIBODY-FORMING CELLS IN THE MOUSE SPLEEN FOLLOWING THE INJECTION OF SHEEP ERYTHROCYTES. Zaalberg, O. B.; van der Meul, V. A.; Rossi, G. (TNO, Rijswijk, Netherlands). Eur. J. Immunol.; 3: 698-703(Nov 1973).

The effects of ionizing irradiation on the formation of plaque-forming cells (PFC) against sheep red blood cells (SRBC) in the mouse spleen were investigated. The radiation effect is expressed as the reduction in numbers of PFC in irradiated mice as compared to the number of these cells in the control mice. A simple negative exponential radiation dose-response relation was obtained with mice which were injected with SRBC 24 h after irradiation. The D37 for both the primary and the secondary IgM and IgG responses under these conditions was about 90 rad. Antigen injection in a period extending from 24 h before, to 2 h after irradiation resulted in a dose-response curve with a shoulder, both for the IgM and IgG response. The doubling time of the number of PFC in the spleen during the first four days after antigen injection was not influenced by irradiation with 186 rad or less. With 279 rad, however, the doubling time increased. An explanation for the shoulder in the dose response curve is presented, which is an alternative to the usual explanation denoted by the multi-hit effect of irradiation as a causative mechanism. It is postulated that the shoulder is a consequence of the masking of the irradiation effect by a process which normally regulates the extent of the immune response. (auth)

12974 TUMOR REJECTION AND IMMUNOTHERAPY STUDIES WITH SIMIAN VIRUS 40-INDUCED TUMORS. Blakeslee, J. R.; von Muenchhausen, W.; Cox, H. R. (Roswell Park Memorial Inst., Buffalo). J. Med. (Basel); 4: 233-247(1973).

Tumor rejection tests were used to further investigate the findings of Cox et al., that foreign cells injected as a mixture with irradiated tumor cells into hamsters increased the level of protection against subsequent tumor cell challenge, as compared to hamsters immunized only with irradiated tumor cells. Administration of xenogeneic cells prior to inoculation with irradiated tumor cells, or equal mixtures of xenogeneic and tumor cells, definitely increased the level of protection against subsequent tumor cell challenge by 10- to 100-fold as compared to hamsters immunized with tumor cells alone. The "enhancing" of "primer" effect of xenogeneic cells was not radiosensitive. It was found that human, reptilian, and bacterial cells enhanced the immune response equally well. A 5-fold increase of both xenogeneic and tumor cells above the standard dose of 60 million cells resulted in apparent immunological paralysis in vaccinated hamsters, manifested by the inability of this group to resist viable tumor cell challenge. Prior sensitization of experimental hamsters to xenogeneic cells, followed by incorporating the same xenogeneic cells into mixtures with irradiated tumor cells and using these as immunotherapeutic vaccines, did not result in any delay or suppression of tumor growth when the vaccines were inoculated into tumor-bearing hamsters by either subcutaneous, intramuscular, or intradermal routes. Autogenous vaccine therapy was unsuccessful in inducing regression or elimination of residual tumor. (auth)

12975 FACTORS AFFECTING THE REACTIVITY OF AMPHIBIAN LYMPHOCYTES IN A MINIATURIZED TECHNIQUE OF THE MIXED LYMPHOCYTE CULTURE. Weiss, N.; DuPasquier, L. (Basel Inst. for Immunology). J. Immunol. Methods; 3: 273-285(Nov 1973).

A miniaturized mixed lymphocyte culture (MLC) assay was developed to study lymphocytes of the toad, Xenopus laevis. The effects of various technical factors such as culture medium, cell origin, length of culture period, cell density, and type of culture plate, on the reactivity of lymphocytes in the MLC, either in the one-way system (with irradiated target cells) or in the two-way system, were investigated. Suitable standard conditions were determined under which (as a minimum) 10^5 thymic lymphocytes from one individual were reacted against an equal number of irradiated or non-irradiated lymphocytes from an unrelated individual in 40 µl of culture medium. The peak of the MLC reaction is on day 4 of culture. (auth)

12976 MODIFICATIONS OF THE THYMIC CELL POPULATION DURING THE DEVELOPMENT OF THE RADIATION-INDUCED LYMPHOMA IN MICE. Boniver, J.; Delrez, M.; Simar, L. J.; Hoat, J. (Univ., Liege). Beitr. Pathol.; 150: 229-245(Dec 1973).

The morphological changes in the thymus during radioleukemogenesis in C_{57} Bl mice were studied mainly on the ultrastructural level. Blast cells, similar to immature lymphoid cells described by KAPLAN with the light microscope, accumulate after a fractionated irradiation. The ultrastructural study shows that this blast cell population is heterogeneous and consists of some typical lymphoblasts and of a majority of peculiar lymphoid cells, i.e. ring-shaped nucleolus cells and X cells. These are identical with X cells appearing in the bone marrow after a single irradiation. All these blast cells remain in the thymus during the whole preleukemic period; they are particularly numerous in the late atrophic thymuses and are still present in the lymphomas. Several arguments support the hypothesis that all these cells belong to the same cellular line and are the target cells for the leukemogenic virus. The nature and the origin of these cells are discussed. (auth)

12977 EFFECT OF THYMUS EXTRACT TP ON ANTIBODY FORMATION IN RATS IRRADIATED AND IMMUNIZED WITH INFLUENZA VACCINE, STRAIN A2. Milcu, S. M.; Boeru, V.; Babes, V.; Panaitiu, G.; Potop, I. Stud. Cercet. Endocrinol.; 24: No. 6, 483-489(1973). (In Rumanian).

The effect of the thymus extract TP on the formation of antibodies in rats irradiated with x-rays at 280 R and immunized by Strain A2 influenza vaccine was studied. The variations of the blood lymphocytes and the activity of glucose-6-phosphatase, succine dehydrogenase, and ATP-ase in the liver were also determined. The administration of TP extract in the irradiated and immunized rats stimulates the development of antibodies with respect to animals irradiated, immunized, or untreated. At the same time there is an increase of the number of serum lymphocytes and modifications of the enzymatic activities studied. (tr-auth)

12978 COMPARATIVE STUDY OF THE ACTION OF IONIZING RADIATIONS AND RADIOMIMETIC AGENTS ON THE INVOLUTIVE AND RECOVERY PHASE OF THE THYMUS OF YOUNG RATS (RATTUS NORVEGICUS ERXL.). II. Effect of Mustard Gas (2,2'-Dichloroethyl Sulfide) and Nitrogen mustard (2,2',2-Trichlorotriethylamine). Cataline, N.; Gibertine, G. (Univ., Rome). Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur.; 53: No. 6, 630-636(Dec 1972). (In Italian).

The effects of two radiomimetic chemical agents (sulphur mustard and nitrogen mustard) on the thymus of Wistar rats were studied and compared with those following x-ray treatment. X irradiation brings about a more severe mitotic block and the recovery takes place in a relatively shorter time. The histological structure appears severely damaged, though for a few days only. Of the two radiomimetic chemical agents, nitrogen mustard displays an action more similar to x irradiation: anyway for both radiomimetic drugs the histological damage appears to be less severe but more prolonged. (auth)

12979 INVESTIGATION OF AMPHIBIAN CHROMOSOME ABERRATIONS RADIATION-INDUCED IN LYMPHOCYTES IN VITRO AT THE G_0 PHASE OF THE CELL CYCLE AT VARYING DOSES OF X-RAYS. Pankova, N. V. (Inst. of Developmental Biology, Moscow). Genetika; 10: No. 4, 55-60(Apr 1974). (In Russian).

Amphibian (Rana temporaria) whole blood samples were irradiated with varying x-ray doses: 100, 150, 250, and 300 R. The frequencies of chromosome aberrations at the first post-irradiation metaphases were studied. Dose-response curves were constructed for dicentrics plus centric rings and acentric fragments (terminal and interstitial). The data were fitted by least squares regression analysis for the models: $Y = a + cD^2$; $Y = a + bD$; $Y = a + bD + cD^2$; $Y = cD^2$. Dicentrics plus centric rings as well as terminal and interstitial chromosome deletions fitted best the model $Y = cD^2$. The coefficients were: $c = 4{,}0 \cdot 10^{-4}$ for dicentrics plus rings/cell/r^2; $c = 3{,}2 \cdot 10^{-4}$ for interstitial deletions/cell/r^2; $c = 3{,}0 \cdot 10^{-4}$ for terminal deletions/cell/r^2. The data indicating the presence of a significant two-track component in the fragment equation are in agreement with those obtained in other leucocyte systems. (auth)

12980 CHROMOSOME ABERRATIONS IN PRIMARY KIDNEY CELL CULTURES OF IRRADIATED MONKEYS. Dzhemilev, Z. A.; Machavariani, M. G.; Trots, A. A. (Inst. of Experimental Pathology and Therapy, Sukhumi, USSR). Genetika; 10: No. 4, 183-185 (Apr 1974). (In Russian).

The object of this study was chromosome aberrations in primary kidney cell cultures in monkeys, γ-irradiated at 620 to 660 R doses and in non-irradiated control monkeys. It was established, that the frequency of chromatid-type aberrations and euploid cells in the irradiated animals did not differ from that in the control. Gamma-irradiation was observed to induce chromosome-type aberrations. The total number of damaged cells and the frequency of unstable aberrations (dicentrics, rings, and fragments) were observed to decrease with increasing time after the irradiation, while the frequency of stable chromosome aberrations (pericentric inversions, symmetric translocations) remained the same during 10 months after the irradiation. (auth)

12981 RELATIONSHIP OF BLOOD-BRAIN BARRIER DAMAGE TO SURVIVAL TIME AFTER ACUTE RADIATION INJURY. Wyant, D. E.; Kabal, J.; Baum, S. J.; Parkhurst, L. J. (National Naval Medical Center, Bethesda, MD). Experientia; 30: No. 4, 415-416 (15 Apr 1974).

The effects of induced blood-brain barrier alterations, in this case lymphatic cervical blockade (LCB), on survival time in rats subsequently exposed to a high dose of radiation (20,000 rads of mixed γ-neutron radiation) were studied. The results show that LCB alone induced no deaths. In irradiated rats there was no difference in the 50% mortality time between LCB and sham operated rats. Extravasation of fluorescein was macroscopically evident in the brain slices of both the sham operated and LCB irradiated animals 48 h after exposure. No extravasation of dye was evident in the sham operated or LCB nonirradiated rats. (ERB)

12982 INFLUENCE OF METHYLMETHIONINE SULFONIUM CHLORIDE (MMSC) ON SURVIVORS OF MICE AFTER X-RAY IRRADIATION, ESPECIALLY, CONSIDERATION OF THE DRUG EFFECT FOR THE DEGENERATION OF INTESTINAL MUCOSA. Kido, K. (Kansai Medical School, Osaka). Kansai Ika Daigaku Zasshi; 25: No. 1, 104-107(Mar 1973). (In Japanese).

Male adult mice of ICR strain weighing 20 to 25g were used. Four groups of mice were organized, each one consisted of ten mice, and every mouse was irradiated by x rays of 700 R. Ten mice belonging to each group of the three were subcutaneously administered with 5, 10, and 20 mg/10 g of methylmethionine sulfonium chloride (MMSC) and the other ten mice, as controls, were administered with saline daily. Then, the number of survivors of each group was plotted. Next, the other three groups comprised of ten mice were organized, and every mouse was irradiated by x rays of 800 R. Each mouse belonging to the two groups was administered with 10 mg/10 g of MMSC, ten mice belonging to the remaining one group were treated with saline as controls, and the survivors were plotted, as above. From the results of these experiments, MMSC might be expected to have an ability to prolong the death time of the mice irradiated by x rays of 700 to 800 R. (auth)

12983 BIOCHEMICAL MODIFICATIONS OF RAT BRAIN IRRADIATED WITH X RAYS (DL_{100}). Boerescu, J.; Gheorghe, N.; Stefan, M. Rev. Roum. Physiol.; 10: No. 6, 479-483(1973). (In Rumanian).

The modifications of the proteins of various cerebral fractions (cerebellum, cerebral cortex, cerebral trunk, and hypothalmus) after x irradiation at a lethal dose and after administration of ATP–vitamin B_1 and CFP–vitamin B_1 mixtures were followed using the electrophoresis disc method. Both in the animals protected by the injections and in the non-protected animals modifications were observed, specifically the appearance of a large number of fractions and a more abundant cleavage in the region of rapid migration. These modifications are visible 4 hrs after irradiation and have an irreversible character during the 72 hrs of observation. (tr-auth)

12984 IMMUNE STIMULATION-INHIBITION OF EXPERIMENTAL CANCER METASTASIS. Fidler, I. J. (Univ. of Pennsylvania, Philadelphia). Cancer Res.; 34: 491-498(Mar 1974).

The interaction of normal, tumor-bearing, nonspecifically sensitized, and immunized syngeneic lymphocytes and the B16 melanoma was tested in vivo by experimental pulmonary metastases. Various numbers of lymphocytes were mixed and incubated with the tumor cells for 90 min on a rotating platform, and then the mixtures were injected i.v. into C57BL/6 mice. Normal, tumor-bearing, and nonspecifically sensitized lymphocytes mixed with tumor cells significantly increased the incidence of experimental metastasis. On the other hand, a high number (5000:1) of immunized syngeneic lymphocytes mixed with the B16 melanoma cells brought about a dramatic decrease in the incidence of subsequent pulmonary metastases. Following the in vitro incubation of tumor cells with syngeneic lymphocytes, clumping of tumor cells was observed. The relative importance of this clumping phenomenon to the outcome of experimental metastasis is discussed. Mice that were either immunized against the B16 melanoma or thymectomized and x-irradiated demonstrated a significant decrease in incidence of experimental pulmonary metastasis following i.v. injection of tumor cells as compared to normal, thymectomized, or x-irradiated mice. The decrease in pulmonary metastases in thymectomized x-irradiated mice was completely reversible with i.v. injection of 1×10^7 syngeneic tumor-bearing lymphocytes administered 24 hr prior to tumor cell injection. On the other hand, administration of 1×10^8 syngeneic tumor-bearing lymphocytes brought about a significant decrease in the incidence of pulmonary metastases in all experimental groups. These results further support the hypothesis and work of Prehn and our earlier reports, that the immune response may have a dual role in its relationship to the development, progression, and perhaps the spread of cancer. (auth)

12985 MECHANISMS OF CHROMOSOMAL ABERRATION PRODUCTION. III. Chemicals and Ionizing Radiations. Bender, M. A. (John Hopkins Univ., Baltimore); Griggs, H. G.; Bedford, J. S. Mutat. Res.; 23: No. 2, 197-212(May 1974).

A general model for the production of aberrations in eukaryote chromosomes is proposed. The basic assumptions of this model are: (1) the chromosome is mononeme, containing but a single DNA double helix before replication; (2) aberrations result only from lesions in DNA; (3) the primary lesions may be either polynucleotide strand breaks or altered bases which are converted to strand breaks either through the operation of enzymatic repair mechanisms or as a consequence of normal semiconservative DNA replication; and (4) final expression of polynucleotide strand breaks as chromosomal aberrations of various types is the consequence of the operation of repair mechanisms, DNA replication, and a single strand DNAse. It is shown that this model is consistent with the available data on chromosomal aberration production by a variety of chemical agents as well as by ionizing radiation. In particular, it accounts for the observed differences in the types of aberrations produced by these two classes of aberration producing agents at different points in the cell cycle. (auth)

12986 ANTIBODY FORMATION IN LUNGS AND LYMPHOID ORGANS IN IRRADIATED ANIMALS. Kevorkov, N. N.; Ravich-

Shcherbo, M. I. (Kursk Medical Inst., USSR). Zh. Mikrobiol., Epidemiol. Immunobiol.; No. 9, 80-84(1973). (In Russian).

Studies were conducted on rabbits immunized with sheep erythrocytes either intratracheally or intravenously to determine the effects of a previous irradiation with 1000 R x rays. Irradiation of intravenously immunized animals inhibited antibody formation by lung, spleen, and paratracheal lymph nodes. However, irradiation of intratracheally immunized animals showed that hemagglutinin formation by lung explants was not inhibited, while that of the other tested tissues was. Studies on plaque formation with cellular suspensions indicated that in the latter case radioresistant alveolar macrophages may have been responsible for antibody production. (JPRS)

12987 MORPHOLOGICAL PICTURE OF HEALING OF THE BRONCHIAL STUMP AFTER PREOPERATIVE EXPERIMENTAL IRRADIATION. Musin, T. B.; Zakhvatkina, I. A.; Abisatov, Kh. A.; Isabekov, Zh. B.; Amangaliev, Zh. A. (Kazakh Scientific-Research Inst. of Oncology and Radiology, USSR). Med. Radiol.; 19: No. 6, 67-70(Jun 1974). (In Russian).

Observations were over 80 dogs, 10 of which were used for control with the purpose of studying the influence of preoperative irradiation on the healing of the bronchial stump. Preoperative irradiation of the lung in 50 dogs was conducted on "Luch-I" apparatus twice a week-800 rad, cumulative focal dose-3200 rad. Preoperative irradiation of the lungs of 20 dogs was conducted on "Rum-17" apparatus with a daily dose of 500 rad, cumulative focal dose of 2000 rad. After the termination of preoperative treatment in animals in 2 days and 2, 3, 4, 5 weeks later pneumonectomy was conducted. Preoperative irradiation of the dose of 2000 to 3200 rad does not retard the healing of the bronchial stump. The most favorable time for conducting the operation is the first two weeks after irradiation. (auth)

12988 FINE STRUCTURAL LOCALIZATION OF THE PYROANTIMONATE PRECIPITABLE CATION IN THE CARDIAC JELLY OF THE RAT EMBRYONIC TUBULAR HEART AFTER NEUTRON IRRADIATION. Satow, Y.; Okamoto, N.; Ueno, T.; Miyabara, S.; Hidaka, N. (Hiroshima Univ.). Senten Ijo; 13: No. 4, 221-233(Dec 1973).

The potassium pyroantimonate precipitable cation distribution was estimated semiquantitatively in the mucopolysaccharide cardiac jelly of A-V canal endocardial cushion of a neutron-irradiated rat embryonic tubular heart. The results revealed that the endocardial cushion showed developmental retardation, and the decrease in the amount of pyroantimonate precipitate, which seems to bind to polysaccharide-protein complex in cardiac jelly was not parallel to that of controls. These morphological and cytochemical findings in the developmental process of cardiac jelly are presumed to represent one of the causal factors of abnormal development in endocardial cushion tissue. (auth)

12989 EFFECT OF PERMANENT MAGNETIC FIELD PRETREATMENT ON HISTOCHEMICAL INDEXES OF THE ADRENAL CORTEX OF X-RAY-IRRADIATED ANIMALS. Finakova, G. V.; Romanov, G. V.; Bykov, E. G.; Piruzyan, L. A. (Inst. of Chemical Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Biol.; No. 6, 913-916(1973). (In Russian).

Experimental results are reported on the effect of permanent magnetic field (PMF) and x-ray irradiation on the contents of sudanophilic lipids, ketosteroids, cholesterol, and nonspecific esterase activity in the rat's adrenal cortex. Animals pretreated with PMF before irradiation did not show any more pronounced changes of the indexes studied in the first 72 h than those treated with x ray alone. The data suggest that PMF pretreatment of animals prevents development of changes in the content of sudanophilic lipids, double refracting substances, nonspecific esterase activity characteristic of isolated x-ray treatment. (JPRS)

12990 FUNDUSCOPIC ALTERATIONS IN THE RHESUS MONKEY INDUCED BY EXPOSURE TO HEAVY ION /0+8/ 250 MeV/NUCLEON. Beckman, F. N.; Bonney, C. H.; Hunter, D. M. (USAF, Brooks AFB, TX). Aerosp. Med.; 45: 154-160(Feb 1974).

A heavy-ion, high-energy beam was extracted from the Lawrence Radiation Laboratory Bevatron, making controlled exposure of biological systems feasible, and a series of experiments were undertaken to determine the possible deleterious effects of such irradiation on the primate retina. The left eyes of 54 rhesus monkeys were exposed to accelerated 0 + 8 (250 MeV/nucleon). Beam flux ranged from 1.3×10 to the 7th particles/sq cm (171 rads) to 5.9×10 to the 8th particles/sq cm (7740 rads). Fundus photography was performed immediately prior to and immediately following exposure, at 24 to 48 hours postexposure and at 1, 2, and 5 weeks postexposure. Punctate hemorrhages of the retina were visible at 1.3×10 to the 7th particles/sq cm (171 rads), the lowest exposure level utilized in this study. Acute radiation retinopathy, consisting of geographic retinal hemorrhage and ischemic necrosis of the retina, was not seen until total flux reached 7.7×10 to the 7th particles/sq cm (1000 rads). (auth)

12991 EFFECT OF CYCLOPHOSPHAMIDE, ^{32}P AND ^{60}Co IRRADIATION ON RABBIT BONE MARROW CELLS. Kissling, M.; Speck, B. (Leiden Univ.). Blut; 27: 167-171(Sep 1973).

The effect of cyclophosphamide, ^{32}P, and whole-body irradiation on rabbit bone marrow cells was studied. They all proved to be mutagenic. Striking quantitative differences of chromosomal aberrations were found in the three groups. (auth)

12992 RESULTS OF CLINICOBIOCHEMICAL INVESTIGATIONS OF DOGS SUBJECTED TO CHRONIC GAMMA RADIATION. Akhunov, A.; Markelov, B. (Polska Akademia Nauk, Warsaw). Artif. Satell.; 8: 197-204(Nov 1973). (In Russian).

From symposium on cosmic biology and medicine; Warsaw, Poland (12 Jun 1972).

Clinical, hematological, physiological, immunological, and biochemical observations and tests were conducted on a group of 186 dogs which were exposed to total gamma ray doses of 106, 312, 610, 625, and 950 R from a cobalt-60 source over a period of five years. Anomalous protein, carbohydrate, and lipoid metabolism was observed in a number of cases. Death of some dogs during the period was attributed to natural causes. (IAA)

12993 DYNAMICS OF CHANGES IN THE GLUCOSE LEVEL IN THE BLOOD AND OF THE LIPID CONCENTRATION IN THE SERUM AND TISSUES OF RATS AFTER CHRONIC EXPOSURE TO SMALL DOSES OF GAMMA IRRADIATION. Alersova, E.; Alers, L.; Sedlakova, A.; Malatova, Z.; Poulikova, U.; Praslicka, M. (Polska Akademia Nauk, Warsaw). Artif. Satell.; 8: 191-195(Nov 1973). (In Russian).

From symposium on cosmic biology and medicine; Warsaw, Poland (12 Jun 1972).

12994 RESPIRATORY METABOLISM AND RADIOSENSITIVITY OF RATS. Noval, L.; Filip, J.; Gosek, B.; Kolacny, I. (Academy of Sciences, Warsaw). Artif. Satell.; 8: 223-229(Nov 1973). (In Russian).

From symposium on cosmic biology and medicine; Warsaw, Poland (12 Jun 1972).

Respiratory metabolism was studied in 246 rats, 7 to 9 weeks old, which were exposed to radioactivity doses of 750 R during different seasons of the year. Survival rates of the rats are given vs their age, season, oxygen uptake, and carbon dioxide release. A relation is established between the survival rates and respiratory metabolic activity. (IAA)

12995 STUDIES ON X-RADIATION INJURY OF THE KIDNEY WITH THE USE OF RADIOISOTOPE RENOGRAPHY. Magaribuchi, S. (Iwate Medical Coll., Morioka, Japan). Iwate Igaku Zasshi; 25: No. 4, 500-515(Aug 1973). (In Japanese).

The bilateral renal function was studied with radioisotope renography following x-ray irradiation of the left kidney in rabbits. Microscopic studies were made of the alterations of bilateral renal tissues following irradiation. Single or serial x-ray irradiation was given to the left kidney of rabbits with 5×5 cm^2 of field size, and with the doses of $1{,}000 \text{ R} \times 1$, $2{,}000 \text{ R} \times 1$, $5{,}000 \text{ R} \times 1$ and $500 \text{ R} \times 10$, respectively. Renography was carried out by intravenous injection of ^{131}I-hippuric acid under thiopental natrium anesthesia. At the early stage, the irradiated kidneys showed a transient rise and prolongation in the renogram curve; these changes were paralleled with the increase of irradiation dose. These curves showed the results of increased renal blood flow caused by x-ray irradiation. The renogram curve of the irradiated kidney showed a nephrectomized pattern 13 weeks after the 1,000 R irradiation, 6 weeks after the 2,000 R irradiation, and 1 or 2 weeks after the 5,000 R irradiation respectively. Therefore, it could be said the larger the irradiation dose was, the shorter the nephrectomized pattern of the irradiated side after the irradiation time. The opposite unirradiated kidney showed a compensative pattern on the renogram, when the irradiation dose was smaller. However, renogram of the opposite side showed an irradiated-side-like damages pattern in the later stage, when the irradiation dose was larger. In the irradiated kidney, atrophy of the cortical layer, diffuse fibrosis of interstitial tissues, hyperemia, cell infiltration, and degeneration of the tubules were observed. In some of the opposite unirradiated kidney, dilatation of the tubules and slight edema of the interstitial tissues were observed. It was noted that the decreased funtion of the irradiated kidney was parallel with the radiation dose, and the function of the opposite unirradiated kidney was also damaged at a later stage following irradiation. It was assumed that this phenomenon might be due to the action of auto-antibody produced in the blood stream by x-ray irradiation to the kidney. (auth)

12996 EFFECT OF GAMMA RADIATION ON TWO DEVELOPMENTAL STAGES OF ZEBRA FISH EGGS. Venkataraman, L. V. (Bowling Green State Univ., OH). Curr. Sci. (India); 43: No. 11, 355-356(5 Jun 1974).

The effect of different doses of γ radiation on two developmental stages (first cleavage stage and gastrula stage) of Zebra fish (Brachydanio rerio) eggs was studied. The results indicate that eggs at earlier stages of development are more sensitive to γ rays than at later stages. The data support the view that the factors associated with cell division are much more sensitive than those associated with differentiation. It is concluded that Zebra fish eggs are highly resistant to γ rays at later stages of development. (ERB)

12997 EFFECTS OF STEROID HORMONES ON THE HEALING OF THE SKIN WOUND AFTER ITS β-IRRADIATION. Yakovleva, N. D.; Zhutaev, I. A.; Kir'yakov, M. A.; Dedenkov, A. N. (Scientific-Research Inst. of Medical Radiology, Obninsk, USSR). Med. Radiol.; 19: No. 6, 41-45(Jun 1974). (In Russian).

The dynamics of healing skin wounds were studied with the help of a microscope and regular planimetry of the wound surface. The edges of such wounds and the bottom were subjected to local β irradiation by a radioactive resolving film with ^{90}Yt (specific activity 100 $\mu c/cm^2$, the absorbed dose in the layer close to the preparation was about 37,500 rad). It was established that under the influence of local β irradiation in the applied dose there was a 5 to 6 day delay in the wound healing. The influence of steroid hormones of the adrenal gland (hydrocortisone and desoxycorticosterone-acetate) on the initial stage of healing revealed itself in some reduction of the wound surface area. At more remote periods of observation hydrocortisone aggravated postradiation inhibition of the reparative process, in animals who were given DOCA the rate of the wound healing increases and a more favorable course of healing was observed with a help of a microscope. However, owing to significant variability of the results a statistically confirmed stimulating effect of DOCA was observed only 10 days after the experimental wounds were inflicted. (auth)

12998 EFFECT OF GVH REACTION ON DIFFERENTIATION AND PROLIFERATION OF HEMATOPOIETIC STEM CELLS. Kitamura, Y. (Osaka Univ.). Saishin Igaku; 28: No. 9, 1733-1739(Sep 1973). (In Japanese).

Based on the literatures from 1916 to 1973, the information on the mechanism of action of GVH (graft-versus-host) reaction was described, and the effect of GVH reaction on growth and differentiation of blood stem cells was explained from experimental studies. Referred to on the experimental studies of GVH reaction were the general conditions, weight gain of the spleen and lymph node, and local GVH reaction of experimental animals, and the in vitro experimental system. As for GVH reaction in humans, the ratio of immune cells in bone marrow cells, clinical symptoms and pathological findings of the reaction, and important points of diagnosis were described. As cells involved in GVH reaction, lymphocytes (T cell) originating in the thymus were referred to as host and donor cells. Effects of GVH reaction on the phagocyte and immunity functions were described. In regard to the effect of GVH reaction on hematopoietic function, host and donor blood stem cells subjected to the effect of activation and growth of T cells were described. The authors performed experiments using CBA-T6T6 mice to elucidate (1) even if GVH reaction occurs, the number of colonies produced in the host spleen by a fixed number of bone marrow cells does not change much; (2) GVH reaction reduces erythrocytic colonies and increases granulocytic colonies; (3) the ratio of erythroblastic colonies to granulocytic colonies (E/G) changes by the x-ray dose irradiated to the host and the volume of lymph node cells of the donor added to bone marrow cells, the larger the x-ray dose and the volume of lymph node cells, the lower the E/G ratio. (JA)

Invertebrates

12999 (AAEC/LIB/Bib-418) SECTION I. Mediterranean Fruit Fly (Ceratitis Capitata (Wied.)) and Section II. Queensland Fruit Fly (Dacus Tryoni (Frogg.)) (Both Diptera: Tephritidae). McDonald, C. J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). May 1974. 65p. Dep. NTIS (US Sales Only) $6.25.

Two hundred and forty-four references to literature on fruit flies pertinent to their radiation control by the sterile male technique are arranged chronologically and alphabetically by author in two sections. Reference to an abstract is given for each entry. (AT)

13000 (AEC-tr-7548, pp 173-176) INFLUENCE OF X IRRADIATION ON OLFACTION IN THE CODLING MOTH LASPEYRESIA POMONELLA L. Pristavko, V. P.; Sherman, L. V.; Chaika, V. N. (Ukrainian Scientific Research Inst., Kiev). 1974. Translated from Radiobiologiya; 14: No. 1, 136-139(1974).

The influence of x irradiation on olfaction in codling moths, a very dangerous pest of fruit orchards, was studied by methods of electrophysiology. During the last decade, this insect species has been intensively studied by radiobiologists in connection with the development of a method of sterilization. (ERB)

13001 (COO-3673-1) VIRUS INDUCED MUTATION AND IRRADIATION. Final Report. Baumiller, R. C. (Georgetown Univ., Washington, D. C. (USA)). 1973. Contract AT(11-1)-3673. 25p. Dep. NTIS $4.25.

Sigma virus infected Drosophila melanogaster were shown to have a higher X-linked, recessive lethal mutation rate than a sigma virus free, "isogenic" strain. This effect was found in both male and female germ lines. A mutant hot spot was located in the virus induced series near the distal portion of the X chromosome, between 0.0 and 2.5 map units; a second possible hot spot was found between 50 to 60 map units. X irradiation was shown to increase recessive lethal mutation frequency in both the virus free and the sigma virus containing strain. (CH)

13002 (UCD-34-P-210-X-1) ANNUAL PROGRESS REPORT, 1 SEPTEMBER 1973-1 April 1974. Boyd, J. B. (California Univ., Davis (USA)). 1974. Contract AT(04-3)-34. 2p. Dep. NTIS $4.00.

Isolation of radiation sensitive mutants of Drosophila melanogaster is being attempted so that a genetic investigation can be made of their properties and interactions. (MCG)

13003 FUNCTIONS OF THE TYPE I CELL SYSTEM AND THE PROBLEM OF ONCOGENESIS IN PLANARIANS. Martelli, M.; Chandebois, R. (Univ. of Provence, Marseille). Oncology; 28: 274-288(1973).

Planarians can form tumor-like outgrowths, either spontaneously, or as a result of various experimental interventions, especially the injection of substances that can be carcinogenic or indifferent. Some tumors represent abnormal excessive regenerates; the others are true neoplasms that rapidly lead to to the animal's death. Experimental factors that provoke the appearance of these neoplasms generally produce, in certain species, lethal regressions of head tissues caused by the cells' incapacity to differentiate, a situation that is analogous to the one produced by x rays. Injections of oil or water provoking these regressions stimulate the mitotic activity of the type I cell system, as do amputations, but only slightly increase the number of mitoses in dedifferentiated material (the syncytium). Planarians having received an injection are more resistant to x rays; this confirms the concept that the stimulation of the type I cell system increases the production of nucleic acids. One can venture the hypothesis that in planarians cancer may be due to factors (injections and an overly rich diet) that increase the production of cells whose cytolysis frees nucleic acids. (auth)

13004 STERILIZATION BY IRRADIATION OF CADRA CAUTELLA (WLK.) (LEPIDOPTERA, PYRALIDAE) MALES INCREASED BY FEMALE SEX PHEROMONE. Calderon, M.; Gonen, M. (Inst. for Tech. and Storage of Agricultural Produce, Tel Aviv, Israel). Experientia; 30: No. 4, 418-419(15 Apr 1974).

The effects of a preferential increase of oxygen tension in the genital tissues, such as may occur in males exposed to female sex pheromone, or the radiation dose required to bring about sterility were studied in Cadra cautella males. The results substantiated the fact that sterile insects could be obtained at lower radiation doses by preconditioning the males with female sex pheromone. (ERB)

13005 DISPERSAL AND SURVIVAL IN THE FIELD OF CHEMOSTERILIZED, IRRADIATED, AND CYTOPLASMICALLY INCOMPATIBLE MALE CULEX PIPIENS FATIGANS. Rajagopalan, P. K.; Yasuno, M.; Labrecque, G. C. (World Health Organization, New Delhi). Bull. World Health Organ.; 48: 631-635 (May 1973).

Comparative field studies were made on the dispersal and survival of chemosterilized, irradiated, and cytoplasmically incompatible (D3 strain) male Culex pipiens fatigans. There was no significant difference in dispersal patterns and daily survival rates between laboratory colony males and wild males, and between chemosterilized or irradiated males and untreated males. Although there was no difference in dispersal between adults of the D3 strain and the laboratory colony of the Delhi strain, the former had a lower daily survival rate. (auth)

13006 INVESTIGATIONS ON RADIOSENSITIVE AND RADIORESISTANT POPULATIONS OF DROSOPHILA MELANOGASTER.

IV. The Genetics of the Relative Radioresistance in Stage-7 Oocytes of the Irradiated Population ROE I. Noethel, H. (Univ., Berlin). Mutat. Res.; 23: No. 2, 163-177(May 1974).

The genetic system that controls the relative radioresistance in an irradiated laboratory population of Drosophila melanogaster (RÖ I) was studied. Comparisons were made between an unirradiated control population (+60, +K), the population RÖ I (after 227 to 333 generations of irradiation at 2100 R per generation), the subpopulation RÖ I_0 (derived from RÖ I after 260 generations of irradiation and kept without irradiation for up to 74 generations), the F_1 hybrids +60/RÖ I, various homo- and heterozygous carriers of the three major chromosomes of RÖ I and +60, respectively, in combination with suitable balancers, and several chromosome substitution stocks of +K and RÖ I. The criteria used to assess the magnitude of radiosensitivity were dominant lethals, x-chromosome loss, and sex-linked recessive lethals induced in stage-7 oocytes at various exposure levels of x irradiation. The data show that the radioresistance in RÖ I is controlled by a stable and homozygous genetic system. The system is semidominant. With respect to the induction of dominant lethals and sex-linked recessive lethals, the relative resistance is mainly contributed by chromosomes I and II. The effects of the two chromosomes are additive, each contributing about half the relative resistance. Resistance to the x-ray induction of x-chromosome loss is solely contributed by chromosome II. The findings suggest that at least two different and independent mechanisms are involved in determining the resistance of the RÖ I population. (auth)

Radionuclide Effects (Internal Source)

13007 (ANL-8070, pp 73-79) EXPERIMENTAL RADIATION PATHOLOGY. Finkel, M. P. Dec 1973.

In Division of Biological and Medical Research annual report, 1973.

The goal of this program is to provide basic data for evaluating the hazard to man from exposure to radionuclides deposited within the body. A search was made for virus in spontaneous and radiation-induced bone cancers of dogs, mice, and man. During the past year the last surviving beagle of the initial long-term ^{90}Sr-toxicity experiment and 11 beagles of an experiment investigating the effect of age and distribution pattern of ^{90}Sr on bone-tumor incidence came to autopsy. Emphasis was placed on the search for, and characterization of, bone-tumor viruses. To date two osteosarcoma viruses and an osteoma virus have been found in mice, and there is substantial evidence for the existence of a human osteosarcoma virus. (auth)

Man

Refer also to abstracts 12674, 12701, and 12912–12914.

13008 THREE CASES OF THOROTRAST LATE DAMAGES. Truebestein, G. K.; Citoler, P. (Univ., Bonn). Med. Klin. (Munich); 68: 1442-1447(2 Nov 1973). (In German).

It is reported of three patients suffering from angioblastic sarcoma of the liver, from Thorotrast-induced malignant tumor, and from chronic myeloid leukemia 23 to 36 years after undergoing a Thorotrast angiography. With help of literature, the development of these late damages, especially of leukemia, are discussed. (auth)

13009 ESTIMATION OF RADIATION DOSE FROM I. V. ADMINISTRATION OF SELENITE $Na_2{}^{75}SeO_3$. Textoris, R. (Kosice Univ., Czech.); Pokorna, I. Cesk. Radiol.; 27: No. 5, 295-298(Sep 1973). (In Slovak).

The feasibility was studied of applying ^{75}Se in the diagnosis of tumors. The detectors were placed above the kidneys, the liver, the thyroid, and the thigh. The measurement was carried out in two patients i.v. administered ^{75}Se in selenite over 34 days after the radioisotope application. Also, the activity of blood samples was measured. The retention curves and the proportion of cumulated activity thus obtained served the calculation of the cumulated activity in the kidneys, the liver, and in the thyroid. The results show that the application of selenite $Na_2{}^{75}SeO_3$ is feasible in spite of the long half-life of ^{75}Se. The absorbed doses were found to be fairly low and absolutely acceptable. (INIS)

Animals

Refer also to abstracts 12941 and 12991.

13010 (AEC-tr-7548, pp 156-158) RADIATION DAMAGE TO RAT GERM AND SOMATIC CELLS AFTER CHRONIC INTAKE OF RADIONUCLIDES. Zhorno, L. Ya.; Yakovleva, N. G. (Leningrad Scientific Research Inst. of Hygiene). 1974. Translated from Radiobiologiya; 14: No. 1, 123-125(1974).

Radiation damage to germ and somatic cells in the case of chronic irradiation by incorporated radioisotopes has been insufficiently studied, in view of which the present investigation was undertaken. The experiments were conducted on 75 noninbred male rats. The animals of the first and second groups received ^{137}Cs and ^{90}Sr perorally daily for 90 days in amounts of 7 μCi and 1.2 μCi per rat, respectively. It is known that ^{137}Cs is one of the uniformly distributed radionuclides, while the well resorbed ^{90}Sr is localized in the bone. In view of this, there are also differences in the distribution of the absorbed doses. Animals were sacrificed 5, 10, 30, 60, and 90 days after the introduction of the radioisotopes. The testes and femurs were fixed in Carnoy's fluid; the extracted seminiferous tubules and pieces of bone marrow were stained with carmine acetate, and squashes were prepared. The frequency of mitoses with chromosome rearrangements (bridges and fragments) was calculated per 100 to 200 anaphases and early telophases. The number of aberrant mitoses in the testes and bone marrow of the control animals was 1.1 ± 0.2 and 9.8 ± 2.5%, respectively. Both in the germ cells and in the hematogenic cells, ana- and telophases with one to two bridges were encountered more often, and those with fragments more rarely. (ERB)

13011 (AEC-tr-7548, pp 177-180) SHORT AND LONG-TERM CONSEQUENCES OF IRRADIATION OF DOGS WITH RADIOPHOSPHORUS IN THE CASE OF ITS PROLONGED ADMINISTRATION IN THE EARLY POSTNATAL PERIOD OF DEVELOPMENT. Chervinskaya, A. F. (Rostov-on-Don State Univ., USSR). 1974. Translated from Radiobiologiya; 14: No. 1, 139-142(1974).

In previous studies the state of higher nervous activity and the structure of the central nervous system of dogs subjected to chronic irradiation with incorporated radiophosphorus at an early age were described. This communication presents the results of prolonged observations of the development, clinical state, and picture of the blood of these animals. (ERB)

13012 (AEC-tr-7548, pp 181-184) BIOLOGICAL EFFECTS OF CURIUM-244 IN THE CASE OF INTRATRACHEAL INTRODUCTION. Semenov, A. I.; Lyubimova-Gerasimova, R. M.; Zalikin, G. A. (Inst. of Biophysics, Moscow). 1974. Translated from Radiobiologiya; 14: No. 1, 142-144(1974).

The isotope in the form of the chloride (pH 3) was administered to male white rats weighing 190 ± 10 g at doses of 0.11, 0.06, and 0.038 μCi/g in the winter period and 0.04, 0.02, 0.01, and 0.005 μCi/g in the summer period. The animals were examined two to five times before the introduction of the radioactive product and then at various periods after treatment. The physiological parameters studied were recorded with piezo and thermo-pickups according to the method proposed earlier. The average lifetime (LV_{50}) of the animals in each group in comparison with LV_{50} after intravenous injection was determined by the method of probit analysis. The death of animals treated with ^{244}Cm at a dose of 0.005 μCi/g by the 180th day was 18.8%. Consequently, the same doses of ^{244}Cm per gram of weight in the case of intratracheal intake are far more toxic than in the case of intravenous injection. (ERB)

13013 (ANL-8070, pp 7-27) NEUTRON AND GAMMA-RAY TOXICITY STUDIES. Ainsworth, E. J. Dec 1973.

In Division of Biological and Medical Research annual report, 1973.

Progress is reported on comparative studies of the effects of γ and fission neutron irradiation on mice. Data are included from studies on late effects following low-dose exposure, the influence of age and strain on survival and recovery following fractionated-dose exposure, injuries to the hematopoietic system following fractionated-dose exposure, and the effects of irradiation on capillary blood flow at intervals of 26 to 78 weeks following single or fractionated-dose exposures. (CH)

13014 (BNWL-SA-5018) CONSIDERATIONS IN ASSESSING THE POTENTIAL HARM TO POPULATIONS EXPOSED TO LOW LEVELS OF PLUTONIUM IN AIR. Bair, W. J. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1974. Contract AT(45-1)-1830. 21p. (CONF-740529-3; SM-184-14). Dep. NTIS $4.25.

From seminar on radiological safety evaluation of population doses and application of radiological safety standards to man and the environment; Portoroz, Yugoslavia (20 May 1974).

Results from experimental animal studies have provided extensive knowledge of the tissue distribution and biological effects of ^{238}Pu and ^{239}Pu. While most of these laboratory studies involved levels of plutonium well above the predicted dose commit-

ments from nuclear power plant operation, the results of these experiments along with the limited data from accidental human exposures can provide a basis for preliminary assessment of the hazards to populations from plutonium that might be released to the environment. Experimental animal studies have identified lung and bone cancer as the most serious effect of low level plutonium exposure. Drawing on the results from experiments with several animal species (dogs, mice, rabbits, rats) and several plutonium compounds, the possibility of deriving risk extimates for plutonium-induced lung cancer on a toxicological basis was explored, thus avoiding the need to consider the spatial distribution of absorbed radiation dose in lung, latent period for cancer induction, etc. Values for the risk of lung cancer resulting from inhaled plutonium ranged from about 1 to 2×10^{-4} per nCi/g lung. (CH)

Nuclide Kinetics and Toxicology

Man

13015 (SSI-1974-4) CESIUM-137 IN A CONTROL GROUP AT THE NATIONAL INSTITUTE OF RADIATION PROTECTION, 1973. Falk, R.; Eklund, G. (Statens Seruminstitut, Copenhagen (Denmark)). Jan 1974. 7p. (In Swedish). INIS.

The amounts of cesium-137 in a control group of around 20 persons employed at the National Institute of Radiation Protection in Sweden have been measured. A whole-body measuring technique was used. Results of measurements performed from 1966 to 1973 are given. (INIS)

13016 EQUIVALENCE AND REVERSIBILITY OF ABSORPTION OF STRONTIUM BY HYDROXYLAPATITE. Golutvina, M. M.; Semochkina, L. S.; Kononykina, N. N.; Ezhova, V. M. Sov. Radiochem. (Engl. Transl.); 15: No. 4, 643-646(1973).

Translated from Radiokhimiya; 15: No. 4, 636-639(1973).

When strontium is in contact with synthetic hydroxylapatite $Ca_{10}(PO_4)_6(OH)_2$, in the first hour there is equivalent replacement of calcium ions from the surface of the crystals by strontium ions from the solution. The removal of strontium from the solution and the appearance of calcium in it were demonstrated by flame photometry. The exchange of strontium-85 for calcium of snythetic and bone hydroxylapatites is practically reversible even for preparations which have absorbed the isotope for a week. Stable calcium, added 20 min after the beginning of sorption, displaces strontium-85 from the crystals of bone mineral completely and 94% when it is added after four hours. (auth)

Animals

Refer also to abstracts 12702, 12882, and 14726.

13017 (AEC-tr-7548, pp 114-120) TRANSPORT AND METABOLISM OF CESIUM AND POTASSIUM. Malkina, R. M.; Otlygin, V. A. (Inst. of Biophysics, Moscow). 1974. Translated from Radiobiologiya; 14: No. 1, 92-96(1974).

The kinetics of the absorption and metabolism of cesium-137 was studied as a function of the time, potassium concentration in the digestive tract, and ouabain level. The data obtained demonstrate an influence of the level of dietetic potassium on the dynamics of the assimilation and excretion of cesium-137 and a generality of the mechanisms of exchange of cesium and potassium. (tr-auth)

13018 (KFK-1639) REMOVAL OF INTERNALLY DEPOSITED TRANSURANIUM ELEMENTS BY Zn-DTPA. Seidel, A.; Volf, V. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Strahlenbiologie). Jun 1972. 5p. ZAED.

The comparative effectiveness of Ca-DTPA and Zn-DTPA in removing internally deposited ^{239}Pu, ^{241}Am, and ^{242}Cm was tested in the rat. The radionuclides were administered in a citrate solution and treatment with three chelate injections (1 mmol $\times$ $kg^{-1} \times d^{-1}$) was begun 6 days later. No essential differences were observed between the two chelates tested. The data indicate that the removal of the isotopes from the liver cannot be a suitable criterion for the effectiveness of treatment in other soft tissue organs. The liver isotope content was reduced to 10% of the controls, whereas the content of other organs, including bone, was never reduced to less than 40% of the control. In liver and lung, the response to treatment was different for ^{241}Am and ^{242}Cm as compared to ^{239}Pu. There was no such difference as far as other organs are concerned. (auth)

13019 (NERC-LV-539-32) BEHAVIOR OF ^{131}I IN AN ARTIFICIAL RUMEN AND IN THE SIMULATED FLUIDS OF THE ABOMASUM AND INTESTINE. Barth, J.; Whittaker, E. L.; Barth, D. S. (National Environmental Research Center, Las Vegas, Nev. (USA)). May 1974. Contract AT(26-1)-539. 11p. Dep. NTIS $4.00.

It was observed that ^{131}I appeared in the blood and milk of cattle very soon after an oral administration of ^{131}I-sodium iodide. It was postulated that ^{131}I could have been converted to volatile iodine in the rumen and transported into the respiratory system by eructation where it could be absorbed. Experiments using the artificial rumen were designed to test this hypothesis. The in vitro conversion of ^{131}I-labeled sodium iodide to volatile iodine was investigated in the artificial rumen and in simulated abomasal and intestinal fluids. In addition, the association of ^{131}I labeled iodide with rumen juice sediment, which includes microflora and feed debris, was also studied. The results show that under the conditions reported here, ^{131}I is not volatile. As much as three percent of the ^{131}I was shown to be associated with rumen juice sediment in the artificial rumen. This value for sediment was reduced to 0.52 percent and 0.038 percent in the simulated abomasal and intestinal fluids, respectively. (CH)

13020 (SRO-642-4) EVALUATION OF THE FACTORS INVOLVED IN BIOACCUMULATION OF GAMMA-EMITTING RADIONUCLIDES IN WHITE-TAILED DEER (ODOCOILEUS VIRGINIANUS). Fifth Technical Progress Report, February 1, 1973–June 30, 1974. Jenkins, J. H. (Georgia Univ., Athens (USA). School of Forest Resources). 1 Apr 1974. Contract AT(38-1)-642. 37p. Dep. NTIS $5.00.

White-tailed deer from seven Southeastern states and nine physiographic provinces were monitored for γ-emitting radionuclides during 1973 and 1974. The largest proportion of samples were from previously determined high intensity areas in the Lower Coastal Plain of Georgia and South Carolina. Determinations of ^{90}Sr were conducted on 51 white-tailed deer collected from throughout the Southeast. Areas of high ^{137}Cs accumulation have also yielded extremely high values for ^{90}Sr with one sample containing 91,118 pCi/Kg wet bone. In an attempt to determine the amount of ^{137}Cs entering the human food chain through wild game consumption, consumers and non-consumers of deer meat were analyzed for ^{137}Cs content. There appeared to be little significant public health hazard from eating wild game. (CH)

13021 SEASONAL CHANGES IN THE WEIGHT OF THE THYROID GLAND IN ALBINO RATS AND ITS CAPACITY TO ACCUMULATE ^{131}I. Manolov, K.; Boyadzhiev, S. (Medical Faculty, Plovdiv, Bulgaria). Byull. Eksp. Biol. Med.; 76: 98-101(Sep 1973). (In Russian).

A change in the weight of the thyroid gland in rats and of its capacity to accumulate ^{131}I was traced in the course of one calendar year. The weight of the gland averaged 8 mg% of body weight and altered depending on the season, with a minimum in February and a maximum in May. The capacity of the thyroid gland to accumulate iodine altered in parallel with the change of its weight, varying within a wider range. (auth)

13022 STUDIES ON EXCESSIVE ORAL INTAKE OF MANGANESE. II. Minimum Dose for Manganese Accumulation in Mouse Organ. Suzuki, Y. (Tokushima Univ., Japan). Shikoku Igaku Zasshi; 30: No. 1, 32-45(Feb 1974). (In Japanese).

Experiments were carried out in an attempt to elucidate the minimum dose of manganese that accumulates in the organs and tissues of mice when over doses of manganese were administered per os. Over doses of manganese to mice were given by way of drinking water and lithium in various concentrations. In experiment I, accumulations of manganese in organs and tissues of young mice were measured by administering various doses of manganese for 26 days. In experiment II, ^{54}Mn was given to the mice by the tube feeding and intraperitoneal injection. ^{54}Mn was given after the administration of Mn from drinking water for 26 to 30 days, and the radioactivities in various organs and whole body were determined from 3 hours to 11 days after giving the radioactive ^{54}Mn. By the long term administration of manganese, the following organs and tissues had a tendency to increase by 1.5 times in comparison with the group of 500 ppM of Mn, i.e., in the group of 1000 ppM; small and large intestines, hair and hide, and blood, in the group of 2000 ppM; liver, heart, lung, stomach, small and large intestines, muscle, hair and hide, and blood, and in the group of 5000 ppM; those were liver, kidney, heart, stomach, small and large intestines, bone, muscle, hair and hide, brain, and blood. The absorption rate of ^{54}Mn from the digestive tracts was from 0.5 to 1.97% in the group of 20 to 2000 ppM. A reverse proportion of retention of ^{54}Mn was observed in the whole body with the administration dose of Mn per os. The retention rates of ^{54}Mn in liver, kidney, pancreas, stomach, small and large intestines were different by the ways of ^{54}Mn administration. The distribution patterns of the ^{54}Mn given by tube

feeding were quite different in the group of 2000 ppM from the others. A retardation of growth rate of the mice administered over 2000 ppM of Mn was observed, and the same was also observed in the long term administration of Mn. The mortality rates of 26 mice of each group of the long term administration of Mn were 11.5%, 30.8%, 25.9%, and 42.6% in the groups of 500, 1000, 2000, and 5000 ppM, respectively. (auth)

13023 AUTORADIOGRAPHIC INVESTIGATION AFTER INCORPORATION AND CONTAMINATION OF RADIONUCLIDES USING PROMETHIUM-147 AS AN EXAMPLE. Hoelzer, F.; Gensicke, F. (Staatliches amt fuer Atomischerheit und Strahlenschultz, Berlin). Isotopenpraxis; 10: No. 4, 150-156(Apr 1974). (In German).

A survey is provided that shows the possibilities of application of the microautoradiographic method for the investigation of radionuclide metabolism. Luminescent matter containing ^{147}Pm is used as an example to describe the microdistribution in mice or guinea pigs relatively after parenteral incorporation or inhalation and after skin contamination. The efficiency of decorporation and decontamination agents is checked. (auth)

13024 REACTIVITY OF ION FLUXES IN RAT AORTA DURING HYPERTENSION AND CIRCULATORY CONTROL. Jones, A. W. (Univ. of Missouri, Columbia). Fed. Proc.; 33: No. 2, 133-137 (Feb 1974).

Studies of the ionic and connective tissue composition of aorta from spontaneously hypertensive rats have indicated little change during the early hypertensive phase compared to Wistar rats. Functional alterations in Na–K transport were noted, however, with spontaneously hypertensive rats exhibiting decreased ability to accumulate K and to extrude Na. The turnovers of ^{42}K, ^{36}Cl, and ^{24}Na were increased in these rats under conditions in which cell volume and ionic concentration gradients were similar to controls. It was hypothesized that increased ionic permeabilities occurred in spontaneously hypertensive rats. These may be related to partial depolarization. The consequences of such behavior were analyzed in terms of an operational model for regulating smooth muscle tension. It was concluded that changes in the operating point for K, Na, and Cl permeabilities would enhance the availability of Ca for contraction. Evidence was also presented for resetting of the input–output relation between bioregulants and ionic permeability changes, perhaps as a result of an altered operating point. It was concluded the alterations in ion fluxes would be consistent with the development of increased vascular reactivity and hypertension in spontaneously hypertensive rats. (auth)

13025 CHEMICAL AND BIOLOGICAL PROPERTIES OF ^{131}I-ALBUMIN MACROAGGREGATES. Jovanovic, V. (Institut za Nuklearne Nauke Boris Kidric, Vinca, Yugoslavia). Nucl.-Med.; 12: No. 4, 328-334(Jan 1974).

The chemical and biological properties of macroaggregates are explained. A rapid and simple chromatographic method is described and a new solvent had been applied consisting of methanol, dimethylformamide and water (70:25:5 v/v). This chromatographic method can also be applied for the examination of the radiochemical purity of other proteins marked with ^{131}I. With the biological method the distribution of the macroaggregate in the organs of the test animals has been examined. The presence of small quantities of $^{131}IO_3$ has no influence on the fixation of the product in the lung of the animals. (auth)

13026 TRANSPLANTATION OF EXPERIMENTAL BONE TUMOR UPON SUCCESSIVE GENERATIONS IN RATS, PRODUCED BY RADIOACTIVE PHOSPHORUS ^{32}P SOLUTION. Takeyachi, H. Nichidai Igaku Zasshi; 33: No. 1, 33-42(Jan 1974). (In Japanese).

Twelve experimental bone tumors were induced by injection of radioactive phosphorus solution ^{32}P into the abdominal cavity of each Wistar rat, once in three to four weeks, and transplanted into the subcutaneous tissue of the same species for generations. Of twelve experimental bone tumors, half were successfully transplanted but the other half were failures. The longest case of successful transplantation was one kept over sixteen generations. The average period required for tumor formation by transplantation for generations was 15.8 days, which shows osteoid formation was 17.8 days and which does not show osteoid formation was 15.8 days. The rate of tumor formation by transplantation for generations was 58.1 percent, the rate for those with osteoid formation was 50.7 percent, and the rate for those without it was 62.2 percent. Histologically, osteosarcoma revealed marked resemblance in all cases between the induced one by ^{32}P injection and the original one, and these findings were quite similar to those of human osteosarcoma. The purpose of this experiment is to obtain osteosarcoma in great quantity with case and within a short period of time. Therefore, the experiment with tumors formed by transplantation for generations is better than that with the original tumors. Among the experimental bone tumors, induced tumor similar to the original tumors is the closest to human osteosarcoma. This may suggest the value of this method which deserves further research to be applied to the basic experiment on human osteosarcoma. (auth)

13027 INCORPORATION OF $^{32}P_i$ AND OTHER RADIOACTIVE PRECURSORS INTO LECITHIN OF BRAIN SLICES OF TRITON WR-1339 INJECTED RATS. Abidel-Latif, Ata A.; McPherson, J. C. (Medical College of Georgia, Augusta). Proc. Soc. Exp. Biol. Med.; 146: No. 2, 522-525(Jun 1974).

Young rats (14 to 20 days old) were injected intraperitoneally with Triton WR-1339 (500 mg/kg body wt.) and at various time intervals they were sacrificed, brain slices prepared then incubated in Krebs–Ringer buffer containing either $^{32}P_i$, [^{14}C] choline or [^{14}C]glycerol. The specific radioactivities of lecithin in brain slices from the Triton injected rats were found to be 13% to 385% as high as those of the controls. Maximal $^{32}P_i$-incorporation into lecithin occurred 8 hr following the administration of the detergent. Formation of lactate was the same in both of the control and Tritonized slices, and no effect of Triton WR-1339 on $^{32}P_i$-incorporation into lecithin of brain slices was observed in vitro. The level of serum cholesterol increased by more than 200% in the 24 hr Tritonized rats. It was concluded that the brain, in addition to the liver, is an organ which responds to Triton administration. (auth)

Plants

13028 (CNAEM-100) VARIATION AND COMPARISON OF THE SUBCELLULAR LOCALIZATION OF ZINC IN DIVERSE BROAD BEAN (VICIA FABA) TISSUES OF INCREASING DEVELOPMENT STAGES. Polar, E. (Cekmece Nuclear Research Center, Istanbul (Turkey)). 1972. 59p. INIS.

Thesis.

Broad Bean (Vicia faba) germinated from ^{65}Zn tagged zinc and grown in a complete nutrient solution containing the radioisotope was used to investigate the subcellular localization of this trace element in young and old leaves, stems, and roots. Also, the possible chemical form of ^{65}Zn present in the vascular sap of these tissues was examined. Zinc content, calculated on a cpm/mg basis (dry weight) was mostly accumulated in the supernatant fraction. Then next in the ribosome fraction of young plant tissues. As these latter age, a relative decrease in the amount of zinc present in the ribosomal and supernatant fraction, while an increase occurred in the cell wall debris, nucleus chloroplasts or protoplasts, showing less difference between the various subcellular fractions from leaves and roots. Stems behaved somewhat in a different way. The majority of zinc present in the vascular sap of young roots was mostly ionic. In stems, the percentage of zinc associated to amino acid was about 50% and that of protein was relatively low, increasing, however, in young leaves at the expense of ionic zinc, while that of amino acids remained constant. Zinc associated to amino acids consisted of the majority of the total zinc present in senescing leaves with very little zinc left in an ionic form. The relationship between these variations with that of the metabolism of the plant is discussed. (INIS)

13029 ENRICHMENT OF $H_2^{18}O$ IN THE LEAVES OF TRANSPIRING PLANTS. Dongmann, G. (Kernforschungsanlage, Juelich, Ger.); Nuernberg, H. W.; Foerstel, H.; Wagener, K. Radiat. Environ. Biophys.; 11: No. 1, 41-52(Mar 1974).

The vapor pressure difference between $H_2^{18}O$ and $H_2^{16}O$ is the reason for the accumulation of the heavy molecule in transpiring leaves. Since photosynthesis on land is the main source of atmospheric oxygen, this mechanism is important for the remarkable enrichment of ^{18}O in atmospheric O_2 (Dole effect). Using a simple box model for transpiring leaves, a quantitative understanding of the isotope fractionation is possible which is well confirmed by the results of model experiments as well as by measurements on trees. Maximum enrichment of $H_2^{18}O$ in the water of leaves (relative to soil water) is 25 per thousand (theoretically, for dry air) and was found under natural conditions to be 21 per thousand (for 28% relative humidity); minimum theoretical enrichment is zero (observed 2.3 per thousand). (auth)

New Tracer Techniques

Refer also to abstracts 12862, 13009, and 13027.

13030 (COO-1653-130(App. 2)) BIOLOGIC CONSIDERATIONS IN ANATOMIC IMAGING WITH RADIONUCLIDES. Appendix II. Potchen, E. J. (Washington Univ., St. Louis, Mo.

(USA). Edward Mallinckrodt Inst. of Radiology). [nd]. Contract AT(11-1)-1653. 6p. Dep. NTIS $4.00.

Studies of regional ventilation and perfusion were performed on more than 350 patients. A new calculation program was completed which enables ventilation-perfusion ratios to be determined from either the early part of the washin of ^{133}Xe, or from the washout of this gas. Preliminary experiments in eight patients showed a significant correlation between the regional distribution of intravenously injected ^{133}Xe and ^{99m}Tc-labeled albumin particles. For the ventilation-perfusion ratio calculations the normalized distribution of the injected particles was used for the perfusion, while either the normalized distribution of tidal volume, or the fractional exchange of air per breath were used as measures of ventilation. Patients with pulmonary embolism had clearly increased regional V/Q ratios, while patients with chronic obstructive lung disease tended to have uneven patterns, with no high V/Q areas. In a few patients suspected of having both conditions, the V/Q scans did not support the diagnosis of pulmonary embolism, and in some of these there was no angiographic support for the diagnosis of pulmonary embolism. (auth)

13031 (TID-26585) CUMULATIVE ADDITIVE TANGENT CORRECTION (CATC): AN IMPROVED TECHNIQUE FOR THREE-DIMENSIONAL RECONSTRUCTION OF RADIONUCLIDE SCAN DATA. Progress Report. Edwards, R. Q.; Ricci, A. R.; Kuhl, D. E. (Pennsylvania Univ., Philadelphia (USA)). Apr 1974. Contract AT(11-1)-3399. 10p. Dep. NTIS $4.00.

The development of the CATC reconstruction technique in order to improve accuracy of reconstruction and to accommodate the increased performance demands of the MARK IV transverse section imaging radionuclide scanning system is discussed. The CATC method is adaptable to a computerized data collection system which allows continuous growth of tangent data as the scan progresses and is fast enough to allow a virtual real time processing display system. With this improvement the MARK IV will be a continuous data collection system that collects data, processes, and displays the processed data in intervals of less than one minute. (auth)

13032 SCINTIGRAPHY WITH ^{67}Ga-CITRATE IN THE CASES OF MALIGNANT TUMOR. Tateno, I.; Kato, S. (National Hospital of Kanazawa, Japan). Rinsho To Kenkyu; 51: No. 1, 277-285(Jan 1974). (In Japanese).

Scintigraphy with ^{67}Ga-citrate was done in the cases of malignant tumor. There were 25 subjects, which consisted of 23 cases of tumors in the lung, the mediastinum, the lymphatic glands, the head and neck, the digestive organ, the pelvis, the bones and the skin, and 2 cases of pulmonary tuberculosis and pneumonia. They received 1.5 to 2.0 mCi of ^{67}Ga-citrate intravenously (developed by RCC) and after 48 to 72 h scintiphotos were taken by gamma camera. Positive rate in the 29 sites of 23 cases of malignant tumor was 82.8% (except after radiation therapy). Positive findings were seen for the cases of lung cancer, cancer of the paranasal sinuses, and the metastasis to the lymph nodes. There were some cases in which it was difficult to evaluate due to eliminated ^{67}Ga into the intestine in the abdominal field. In addition, it was suggested that the amount of accumulation of ^{67}Ga in this site was low, compared with other sites. The extent of malignant tumor and metastasis which were unable to be detected by x-ray photo and palpation were seen by scintiphotos with ^{67}Ga. It was effective to decide the irradiation field in radiation therapy and to know the effectiveness of radiation and the sensitivity of radiation. There was no side effect by ^{67}Ga-citrate. (JA)

13033 SCINTIGRAPHIC METHODS FOR FUNCTIONAL EXPLORATION OF THE LUNGS. Demedts, M. (Univ., Leuven, Belg.); De Roo, M.; Vandecruys, A.; Kiebooms, R. K.; Drieskens, L.; Cosemans, J.; Gyselen, A. Acta Tuberc. Pneumol. Belg.; 64: No. 2, 101-119(1973). (In French).

A short summary is given of the scintigraphic methods for functional exploration of the lungs. The various apparatus and tracers are discussed as well as the procedures for examination of the subjects and handling of the data. Also the normal regional distribution of ventilation and perfusion is briefly dealt with. On the other hand our method, based on the use of a gamma-camera, ^{133}Xe, and computerized data handling is explained, and some examples of our results in normal and pathological cases are presented. (auth)

13034 CORRELATION BETWEEN BLOOD RADIOACTIVITY LEVELS AND TEMPORAL COUNTING VALUES AFTER ADMINISTRATION OF ^{131}I-TRIOLEIN TEST MEAL. Kaneko, T. (Kumamoto Univ., Japan). Kumamoto Igakkai Zasshi; 47: No. 4, 274-279(Apr 1973). (In Japanese).

The ^{131}I-triolein absorption tests were performed on thirty patients as following: 1. A ^{131}I-triolein capsule (75 to 100 μCi) was administered with approximately 100 ml of warm water after both thyroid blockade and an overnight fast. 2. The blood radioactivity levels (% of dose) were determined at hourly intervals after administration by the routine method. 3. At the same time, the temporal counting was also performed by a scintillation counter. And then, correlation coefficient between blood radioactivity levels (% of dose) and temporal counting values was investigated on each patient and a very high correlation was found to exist. It may therefore be concluded that the method of the temporal counting may be used instead of the method of the measurement of blood radioactivity levels to study the blood curve pattern of the ^{131}I-triolein absorption test. (auth)

13035 RAPID METHOD FOR THE RADIOIMMUNOASSAY OF URINARY ALDOSTERONE. Stuart, J.; Keane, P. M.; Viol, G.; Gupta, R. N. (St. Joseph's Hospital, Hamilton, Ont.). Clin. Biochem.; 6: 285-294(Dec 1973).

The availability of an antiserum to aldosterone γ-lactone allows the rapid assay of aldosterone in urine. Following acid hydrolysis of the 18 oxo-conjugate, aldosterone is oxidized to its γ-lactone. The extremely low cross reactivity of the antiserum with structurally related steriods obviates the need for chromatographic purification before radioimmunoassay. This procedure is sensitive enough to allow the assay of aldosterone in the equivalent of 25 UL of hydrolyzed urine. (auth)

13036 ESTIMATION OF SERUM AND RED CELL FOLATE BY A SIMPLE RADIOMETRIC TECHNIQUE. Mincey, E. K.; Wilcox, E.; Morrison, R. T. (Vancouver General Hospital, British Columbia). Clin. Biochem.; 6: 274-284(Dec 1973).

Estimation of serum and red cell methyltetrahydrofolic acid (MTHFA) was performed by a simple radiometric assay using the folate binder in cow's milk and ^{3}H pteroylglutamic acid ($^{3}HPGA$) as tracer folate. Results of the radioassay and L. casei assay on 180 serum samples and some whole blood samples were compared. The mean radioassay results were slightly lower but still offered essentially the same degree of diagnostic information. The test procedure was considered acceptable for routine laboratory use. (auth)

13037 STUDY OF THE GASTRIC EMPTYING AFTER ADMINISTRATION OF ^{131}I-TRIOLEIN CAPSULE TEST MEAL. Kaneko, T. (Kumamoto Univ., Japan). Kumamoto Igakkai Zasshi; 47: No. 4, 268-273(Apr 1973). (In Japanese).

After both thyroid blockade and an overnight fast, a ^{131}I-triolein capsule (75 to 100 μCi) was administered with approximately 100 ml of warm water. A gamma camera was collimated on the patients abdomen and gastric emptying was studied by the observation of the gastric image on the CRT display of the data processing system. A total of 102 cases including 24 of normal cases was studied. In normal cases, gastric emptying occurred within 2 hours after administration. In both 15 cases of gastric resection and eight cases of hyperthyroidism, gastric emptying occurred within an hour after administration. In three cases of hypothyroidism, the delay in gastric emptying was observed and gastric emptying time was more than 4 hours after administration. The gastric emptying of the other pathological cases occurred within 2.5 hours after administration. (auth)

13038 RADIOMETRIC METHOD FOR THE ASSAY OF VITAMIN B_{12}[CYANOCOBALAMIN] IN PHARMACEUTICAL PREPARATIONS. Cocola, F.; De Gori, V.; Tarli, P.; Neri, P. (ISVT, Siena, Italy). Farmaco (Pavia) Ed. Prat.; 28: No. 7, 388-395 (1973).

Freeze-dried rabbit serum is used, in place of human serum or the intrinsic factor, as a new specific binder for cyanocobalamin (I). The standard graph is first constructed by adding, to a series of tubes, the following solution in order: 0.125 m-acetate buffer of pH 4.6 (5 ml), unlabelled I (from 25 to 500 pg dissolved in 2 ml of H_2O) and [^{57}Co]I (100 pg per ml). After mixing, rabbit serum (0.5 ml) is added at the optimal dilution, and the tubes are set aside for 1 hr at room temperature. Charcoal (50 mg) plus bovine serum albumin (10 mg) suspended in H_2O (2 ml) are added and the tubes are shaken at 10-minute intervals for 30 min. and centrifuged at 3000 r.p.m. The supernatant liquid (2 ml) is measured into a well counter, for radioactivity determination, and the number of counts is subtracted from a blank prepared by omitting the rabbit serum and unlabelled I. The calibration graph is rectilinear only over a limited range; the optimal range is from 50 to 200 pg of I and the sample is diluted if necessary. The method is highly sensitive and specific and a number of analyses can be performed at the same time. (tr-auth)

13039 LUNG SCANNING WITH ^{99m}Tc-ALBUMIN MICROSPHERES. Abe, M.; Tanno, M.; Chiba, K.; Yamada, H.; Matsui, K. (Tokyo Metropolitan Geriatric Medical Center). Kaku Igaku; 11: No. 1, 45-52(Feb 1974). (In Japanese).

The labelling efficiency employing ^{99m}Tc-Albumin Microspheres Kit (AMS kit) of 3M Co., Ltd was studied. The lung scanning was carried out on 34 patients with pulmonary diseases such as bronchitis, pneumonia, pulmonary cancer, pulmonary emphysema, and tuberculosis ranging from 56 to 88 years of age. The ^{99m}Tc-labelling procedures should be performed continuously in aseptic conditions. The amount of 40 mCi/10 ml of $^{99m}TcO^-$ together with 2 ml of air was added to the labelling vial containing 5 mg AMS, and shook completely in the ultrasonic vessels for 2 minutes. After boiling for 6 minutes in the heating vessels, it was shook in the water. The labelling was performed during these procedures. In this experiment, various heating vessels were tried in order to improve the labelling efficiency. It is necessary to rinse the AMS with abluent to keep the isolation of $^{99m}TcO_4^-$ at the minimal amount when it has passed more than three hours after the labelling. Also, the vial must be employed within 8 hours after the labelling. The 2 to 4 mCi of the labelled AMS, which was removed from the labelling vial after being stirred in the ultrasonic vessels, was injected to the patient in supine position intravenously. The scintigrams in four projections (anterior, posterior, and both lateral projections) were taken with a γ-camera and scintiscanner. The labelling efficiency was calculated from the amount of radioactivity of $^{99m}TcO_4^-$ which was labeled to AMS and the total amount of $^{99m}TcO_4^-$ radioactivity. By improving the heating method, shaking method, and the labelling time, the improvement of the labelling rate of ^{99m}Tc was obtained. Consequently, the value ranged from 78% to 41%, and averaged 56%. (JA)

13040 RADIOIMMUNOASSAY FOR PLASMA GLUCAGON USING POLYETHYLENE GLYCOL. Ohneda, A.; Ishii, S. (Tohoku Univ., Sendai). Tonyobyo; 17: No. 1, 23-27(Jan 1973). (In Japanese).

Experimental studies were performed to evaluate the application of separation by polyethylene glycol (PEG) to the immunoassay of plasma glucagon. An increase in the concentration of PEG added raised the percentage of precipitated bound ^{131}I-glucagon, reaching a plateau at a 12.5% final concentration of PEG. The bound labeled glucagon was completely precipitated by the addition of γ-globulin of human plasma in a final concentration of 0.15 mg/ml. The maximal percentage of bound labeled glucagon precipitated was observed at pH 7 to 9. The standard curve for glucagon assay using PEG was parallel to that using the charcoal method. The glucagon levels in the pancreatic vein of a dog measured by the PEG method correlated with those by the charcoal method (r = 0.832). These results suggest that the PEG method for the separation of free from bound labeled glucagon is useful and superior to other methods for the radioimmunoassay of plasma glucagon. (auth)

13041 PLASMA GROWTH HORMONE IN PRIMARY ALDOSTERONISM. I. Radioimmunoassay by Double Antibody Method of Unextracted Plasma for Human Growth Hormone. Fukuchi, S. (Tohoku Univ., Sendai). Tohoku Igaku Zasshi; 86: No. 2, 75-80 (Mar 1973). (In Japanese).

Estimation of human growth hormone (HGH) in unextracted plasma was undertaken by radioimmunoassay using double antibody method. 0.1 ml of ^{131}I-HGH and 0.1 ml of diluted rabbit anti-HGH serum were added to the test tubes containing 0.2 ml of each plasma diluted in 0.8 ml of 5% BSA borate buffer, pH 8.0. The tubes were then incubated at 4°C for 72 hours followed by adding 0.1 ml of 1:200 normal rabbit serum, and finally 0.1 ml of diluted sheep anti-rabbit γ globulin serum. The tubes were incubated for another 72 hours at 4°C and centrifuged at 4°C for 20 minutes. The precipitate were recentrifuged after washing with cold saline solution and then counted in Pachard gamma counter. The percentage ^{131}I-HGH precipitated was calculated and compared with that obtained from standard solution. Nonspecific inhibitor in human plasma could be eliminated by use of 5 times diluted plasma. The sensitivity of this method was limited to less than 0.3 mμg/ml. The normal range by this assay was between less than 0.3 to 4.0 (mean 2.03 ± 0.26) mμg/ml, HGH levels in plasma were 1.70 ± 0.29 mμg/ml in 16 diabetic patients. High values were found in six active acromegalic patients. The present method offers two distinct advantages; greater sensitivity and all manipulations at room temperature. (auth)

13042 SIMPLIFIED RADIOIMMUNOASSAY FOR PLASMA TESTOSTERONE. Shirai, M.; Matsuda, S.; Nakamura, M.; Yonezawa, K. (Tohoku Univ., Sendai). Rinsho Hinyokika; 28: No. 3, 269-273(Mar 1974). (In Japanese).

The practical use and precision of modificated radioimmunoassay for measuring plasma testosterone by simplifying the extract method and omitting chromatography, was evaluated. The results were fair with coefficient of variation of 4.8% and average recovery rate of 94.5 ± 2%. Plasma testosterone of normal males ranged between 430 and 1,180 ng/dl by this method with the average 628 ± 236 ng/dl. On the other hand, the value obtained by normal females was 36 ± 1.9 ng/dl and the average value obtained by water blank was 1.9 ± 1.2 ng/dl. (auth)

13043 STUDIES OF CEREBROSPINAL SPACE SCINTIGRAMS. III. Myeloscintigrams. Furuta, A. (Kanto Rosai Hospital, Kawasaki, Japan); Oshima, H.; Tachibana, T.; Awataguchi, T.; Suzuki, K. Kaku Igaku; 11: No. 1, 23-32(Feb 1974). (In Japanese).

One hundred and forty four myeloscintigrams were made during the period from 1969 to 1973. Among those cases, 55 could be ascertained with oil myelography, operations, and other means. The scintigrams were taken one hour after infusion of ^{131}I-HSA 100 to 200 μCi and ^{169}Yb-DTPA 0.3 to 1 mCi through lumbal puncture or cisternal puncture. The needles used for puncture were slender ones of 21 to 22 gauges, and leakage of the liquor was prevented after puncture. In 55 cases, 17 intervertebral-herniations, 6 thickenings of the lig. flavum, 2 extradurarvarices, 3 canal stenosis, 6 spinal cord tumors, 3 spinal metastasis of carcinoma, 6 patients of paraplegia and 9 brachial plexus injuries were observed. As it is seen in the above cases, myeloscintigraphy can show the condition in the space and apply to various diseases. (auth)

13044 RADIOIMMUNOASSAY OF PROTEOHORMONES. Vigas, M. (Slovenska Akademia Vied, Bratislava). Bratislav. Lek. Listy; 60: No. 1, 109-116(Jul 1973). (In Slovak).

The principle of radioimmunochemical methods and a survey of procedures of determining proteohormones by the mentioned methods are presented. Proteohormones in the blood plasma can be determined by a tracer amount of a radioiodine-labeled hormone. The manner of obtaining antibodies, whose reactions with hormones are essential for determining the proteohormones, is given. (INIS)

13045 LUNG PERFUSION SCINTISCANNING IN THE HEMODYNAMICS OF THE LESSER CIRCULATION. Angelino, P. F.; Algranati, R.; Tortore, P. (Holy Cross Hospital, Cuneo, Italy). Minerva Med.; 64: No. 69, 3595-3603(3 Oct 1973). (In Italian).

The main principles of lung scintiscanning are explained and a personal series is presented. Particular attention is given to changes in the scintiscanning picture observed in cardiopathy and chronic bronchopneumopathy. It is pointed out that the technique can give early warning of increased resistance and hence the possibility of right heart overloading. It is also suggested that lung scintiscanning can be usefully employed in the preliminary screening of cardiac catheterisation, angiopneumography, and angiocardiography candidates. (auth)

13046 COMPARATIVE DETERMINATION OF CIRCULATING TOTAL BLOOD VOLUME USING ^{51}Cr AND ^{131}I. With Special Reference to the Determination of Extremely Small Amount of Circulating Blood. Shimazaki, S.; Tanaka, N.; Ogawa, M.; Sugimoto, T. (Osaka Univ.). Nippon Saigai Igakkai Kaishi; 21: No. 10, 498-504(Oct 1973). (In Japanese).

Body fluid and the state of the extremely small amount of peripheral circulating blood were directly studied in patients with serious wounds, using ^{131}I-labeled albumin (RISA) and ^{51}Cr-labeled red cells (^{51}Cr-RBC). After the intravenous injection of the ^{51}Cr, blood samples were drawn at intervals of 5–10 minutes at least three times. Measurement values were plotted on the graph of the logarithm. RISA was injected in 24 cases with serious wounds, of which 4 cases received immediately after wounds, 5 cases immediately after operation, 5 cases at the steady state, 5 cases at the early stage of burn, and 5 cases at the state of brain death. The decrease of the tracer was remarkably seen in the cases with burn and with brain death. The amount of circulating erythrocytes was measured in the state of brain death in 12 cases with brain death. The amount of circulating erythrocytes averaged 1500 ± 100 ml before brain death. However, it was 790 ± 70 ml at the state of brain death, which showed the significant decrease. The changes of hematocrit revealed a significant decrease at the state of brain death. ^{51}Cr-RBC was infused before treatment with high-pressured oxygen (OHP) in 4 cases with acute carbon monoxide poisoning. The amount of circulating blood was increased after OHP in all cases. F cell ratio (Fahreaus rate) was measured by simultaneously infusing ^{51}Cr-RBC and RISA (double tracer method). The average value of F cell ratio was 0.87 ± 0.014 in 13 cases with serious wounds. Especially, F cell ratio showed the low values in cases with brain death in which peripheral pooling of blood cells was remarkably seen and the cases with brain death in which discharge of plasma was severely seen. The relationship between hematocrit-gradient and base-excess was studied in 11 cases with serious wounds. As a result, there was some difference between them. The hematocrit in the peripheral capillary vessels showed the high value, with the decrease of base-excess, compared with hematocrit of the large blood vessels. (JA)

13047 STUDIES OF REGIONAL LUNG FUNCTION USING RADIOACTIVE XENON. Sasaki, M. (Hiroshima Univ.). Med. J. Hiroshima Univ.; 21: No. 9-10, 559-618(Oct 1973). (In Japanese).

Radioactive xenon technique to evaluate regional pulmonary function in the upper and lower zones of the right and left lung was carried out in 33 normal subjects and 51 subjects with pulmonary diseases. The measurement was made in supine position. Blood flow rate(Q), ventilation rate(V), functional residual air (FRC), blood flow efficiency (Ind. Q) and V/Q were determined, while time for washing out 50% of ^{133}Xe(T ½) and 90% ^{133}Xe(90% WOT) and λ, which presented the characteristics of the ^{133}Xe clearance curve, were estimated. In normal subjects, the values of Q, V, and FRC were higher in the right lung than in the left lung. In both lungs, the values of Q, V, and FRC were a little higher in the lower zone than in the upper. The values of V/Q were slightly higher in the lower zones of both lungs than in the upper ones. The estimated T ½, 90% WOT, and λ were prolonged with patient's aging, above all remarkably in old subjects at the age of 61 years or more. In the cases with the first and second types of chronic bronchitis (Nishimoto's clinical classification), their regional pulmonary functions were normal, while in the cases with the third and the fourth types of the same disease, which suggested more progressive stages, the variance in V/Q was larger and the estimated T ½, 90% WOT, and λ were longer. In the subjects with primary lung cancer, Q, V, FRC, and V/Q of both hilus and lung field were lower in the lesion than in non-pathological zone. T ½, 90% WOT, and λ were obviously prolonged. In the cases of II Group of bronchiectasis (Sugiyama's morphological classification), Q, V, FRC, and V/Q were lower T ½ and 90% WOT were longer at the bronchiectatic region than at the non-bronchiectatic zone. The regional pulmonary function of the subjects with pulmonary fibrosis was almost the same as that of the normal subjects. In the cases with bronchial asthma, Q, V, and FRC were slightly lower and slight elongation of T ½ and 90% WOT were seen at the time of attack, and all changes returned to normal in asthma-free periods. (JA)

13048 METHOD OF SEPARATE COUNTING OF THE BLOOD SAMPLE LABELED WITH ^{59}Fe AND DF^{32}P FOR THE DETERMINATION OF IRON METABOLISM AND MEAN RED CELL LIFE SPAN. Saito, H. (Nagoya Univ., Japan). Nippon Ketsueki Gakkai Zasshi; 36: No. 6, 859-864(Dec 1973). (In Japanese).

Iron-59 and DF ^{32}P are used frequently in series for the determination of iron metabolism and mean red cell life span. However, the radioactivity of these isotopes is counted more or less mixed each other in well-type scintillation counting for ^{59}Fe and Geiger- or liquid scintillation counting for ^{32}P. Therefore, it is necessary for the accurate determination of iron metabolism and mean red cell life span to count ^{59}Fe and ^{32}P of the blood sample separately. To exclude the mixing of radioactivity of ^{32}P in counting ^{59}Fe, the methods of using channels ratio, decay ratio, and lead filter were investigated, and the use of lead filter was simplest and most effective. Using a 2 mm thick lead tube, 97% of the radioactivity of ^{32}P was cut at a sacrifice of 18% of ^{59}Fe radioactivity. To exclude the mixing of radioactivity of ^{59}Fe in counting ^{32}P, use of an aluminum filter, subtraction of ^{59}Fe counts of the sample before injecting DF ^{32}P from after, and ^{59}Fe-heme extraction method were tested. The ^{59}Fe-heme extraction method was the best. By heme extraction with hydrochloric acid acetone, 98% of ^{59}Fe was removed without any significant loss of ^{32}P. The method of heme extraction was applied for determining mean red cell life span of the blood sample obtained from various patients, and the results were satisfactory. (auth)

13049 RADIOISOTOPES IN MODERN PULMONARY FUNCTION DIAGNOSTICS. Konietzko, N.; (Univ., Ulm, Ger.); Matthys, H.; Adams, W. E. Muenchen. Med. Wochenschr.; 116: No. 4, 159-168(Jan 1974). (In German).

The introduction of radioisotopes in pulmonary diagnostic techniques has broadened the knowledge of the physiology and pathophysiology of the lungs, and also of the non-respiratory functions of this organ. The preparation of appropriate radiopharmaceuticals, the development of new detector systems allowing simultaneous scanning of the lungs, the use of electronic computers for the recording and processing of measured data have laid the basis for the application of nuclear medical techniques in clinical pulmonary function diagnostics. Stationary detectors (scintillation cameras) are used, and the radioisotopes are gases with either high solubility (^{15}O; $C^{11}O_2$), or low solubility (^{133}Xe; ^{135}Xe; ^{81}Kr) in water, as well as colloidal or molecular solutions labelled with ^{99m}Tc, ^{131}I, or ^{113}In. The application of these methods is discussed, in particular the use of ^{133}Xe in the determination of the lung volume, ventilation and perfusion under normal and pathological conditions such as bronchial carcinoma, pulmonary tuberculosis, bronchial asthma, bronchitis, and primary perfusion disturbances. (GE)

13050 SCANNING OF THE LIVER WITH ^{198}Au, ^{111}In, AND SELECTIVE ANGIOSCANNING WITH MAA-^{131}I WITH TUMORS OF THE ABDOMINAL CAVITY ORGANS. Khripta, F. P. (Kiev Scientific-Research Inst. of Urology and Nephrology). Med. Radiol.; 19: No. 6, 58-67(Jun 1974). (In Russian).

Results were analyzed of radioscannography of the liver and other organs in 36 patients. Out of the total number in 20 of them scanning and selective angiography of the liver (angiography of the celiac artery and supramesenteric artery, if necessary, aortography and so on) were conducted, in 5 patients—scanning of the liver and transumbilical portohepatography, in 11 patients—selective arterioscanning and arteriography of the liver and other organs of the abdominal cavity. It was established that scanning of the liver in comparison with selective arteriography of this organ and transumbilical venoportography has practically the same diagnostic value. At the same time arterioscanning with MAA-^{131}I is considerably worse than selective arteriography of the liver and other organs of the abdominal cavity and, apparently, cannot be considered as a perspective method. The study of patients with suspicion of the tumor of the liver should be started with radioisotope determination of its function and scanning and then, if necessary, angiographic methods should be used. (auth)

13051 PROCEEDINGS OF THE 26TH ANNUAL CONFERENCE ON ENGINEERING IN MEDICINE AND BIOLOGY. Volume 15. Conference Held in Minneapolis, Minnesota, September 30—October 4, 1973. Arlington, VA; Alliance for Engineering in Medicine and Biology (1973). 461p. (CONF-730974-).

Extended summaries are presented of the 434 papers presented at the conference. Separate abstracts were prepared for three of these papers. The other papers discuss various aspects of biomedical engineering and instrumentation. (ERB)

For abstracts of individual papers see: 12839, 12934, and 13052.

13052 COMPUTER AIDS IN EVALUATION OF THE RADIONUCLIDE IMAGE OF A BONE SCAN. Ledley, R. S.; Huang, H. K. (Georgetown Univ., Washington, DC). pp 377 of Proceedings of the 26th Annual Conference on Engineering in Medicine and Biology. Vol. 15. Arlington, VA; Alliance for Engineering in Medicine and Biology (1973).

From 26th conference on engineering in medicine and biology; Minneapolis, Minnesota, USA (30 Sep 1973). See CONF-730974-.

Although simple viewing of radionuclide images is often adequate for the solution of many clinical problems, the full diagnostic potential of nuclear data cannot be realized without computer quantitation. The advantages of a computer in the interpretation of a typical bone scan image are illustrated. (ERB)

13053 PRINCIPLES AND TRENDS OF RADIOPHARMACOLOGY. Herzmann, H.; Deckart, H. Radiobiol.-Radiother.; 15: No. 1, 1-13(1974). (In German).

Nuclear pharmaca besides the electronic equipment are the most important tools of the nuclear physician. The task of the scientist developing radiodiagnostics is very complex and extends from finding out possible working points for the testing of specific function, assessing the material and apparatus expenditure to the radiochemical preparation and pharmacokinetic assay. The organism can be regarded as a complicated system of coupled control loops. Therapeutics act on them, diagnostics measure controlled and perturbing variables. Despite the lack of fundamental works on diagnostics research nuclear pharmaca could contribute to the rapid development of nuclear medicine. Tasks and fate in organism of some pharmaca classes (therapeutics, x-ray contrast media, nuclear pharmaca) are analyzed; physical and physiological criteria of nuclear pharmaca are recommended. By the example of organic Hg compounds the task of organ receptor for pharmaca binding is represented. The double function of mercury as an analytical and biochemical agent is the cause of the high radiation dose. After the representation of the specific advantages and disadvantages, respectively, of the physical half-life of radionuclides some remarkable developments of the last years in the field of radiodiagnostics are entered into. In particular the following preparations are critically evaluated: ^{99m}Tc compounds are at the top of generator nuclides, ^{99m}Tc distinguishes itself by always new, manifold labelling possibilities. ^{113m}In compounds: Important as for technetium is the formation of complexes and colloids. Cyclotron isotopes rapidly increase in importance. For the extremely short-lived radionuclides ^{11}C, ^{13}N, ^{15}O with half-lives of a few minutes the immediate neighborhood of a cyclotron for the nuclear medical institution is an absolute demand. Longer-lived cyclotron isotopes with half-lives of a few hours up to days are now already very interesting, just as ^{18}F, ^{43}K, ^{67}Ga, ^{123}I, ^{111m}In. Furthermore, the use of barium compounds, rare earths, and cesium isotopes are reported and the present possibilities and works with nuclear pharmaca for tumor diagnosis are discussed. Finally it is emphasized that a reserve

against new compounds is right until it becomes clear after thorough assay that the new preparation is more useful than those present. (auth)

13054 LEGAL PRINCIPLES OF ASSAY AND ADMISSION OF RADIOPHARMACEUTICALS. Seidenglanz, G. (Deutsche Institut fuer Arzneimittelwesen, Berlin). Radiobiol.-Radiother.; 15: No. 1, 15-17(1974). (In German).

Radioactive pharmaceuticals underlie the valid pharmacological regulations. Before a radioactive substance is admitted as a pharmacon, pharmaceutical and pharmacological as well as clinical assays are necessary. Clinical assay cannot be done before the two other assays are finished. For radioactive pharmaceuticals it requires besides the consent of the Central Expert Board that of the State Center of Radiation Protection. If effectiveness and harmlessness of the tested substance is proved in these assays it is registered in the Register of Pharmaca. (auth)

13055 LABELED AROMATIC MERCURY COMPOUNDS FOR RENAL DIAGNOSIS. Experimental Results. Schwartz, K. D.; Deckart, H.; Herzmann, H.; Flentje, H.; Blottner, A. Radiobiol.-Radiother.; 15: No. 1, 39-46(1974). (In German).

As a result of comprehensive animal experimental investigations mercury-containing carrier substances together with other physically more favorable marker nuclides than mercury isotopes are demonstrated by the example of substituted benzoic acids and benzenesulphonic acids to be used in renal scintigraphy. (auth)

13056 ^{99m}Tc–Sn–COLLOID FOR LIVER DYNAMIC STUDIES. Colombetti, L. G. (Loyala Univ., Hines, IL). Radiobiol.-Radiother.; 15: No. 1, 47-53(1974).

A simple way to prepare a ^{99m}Tc-labeled colloid is presented and its characteristics analyzed. The colloid is prepared by reconstructing a lyophilized solution of $SnCl_2$ and adding the desired amount of pertechnetate solution. To obtain good tagging it is recommended that Methyl-ethyl, ketone extracted or, better yet, sublimed technetium be used. Animal distribution as well as dynamic studies performed in animals showed that this colloid can be a valuable new contribution to the radiopharmaceuticals already on hand for reticulo-endothelial system studies. (auth)

13057 ALBUMIN MACROAGGREGATES CONTAINING ^{113m}In-SULFIDE (^{113m}In SMAA): TECHNIQUE FOR THE PREPARATION OF A NEW LUNG SCANNING AGENT. Csetenyi, J.; Szamel, S. I.; Fuzi, M.; Karika, Z. (Inst. of Oncology, Budapest). Radiobiol.-Radiother.; 15: No. 1, 55-61(1974).

A rapid and simple method for the preparation of albumin macroaggregates containing ^{113m}In for perfusion lung scintigraphy was developed. The main advantages of ^{113m}In-SMAA formed by above procedure are: no centrifugation or use of ion-exchange resins must be necessary and, in contrast with the conventional lung scanning agents containing ^{113m}In, no metallic compounds as carrier, or gelatine, or stabilizer are included. It is harmless, pyrogen-free, biodegradable in the lung and stable within an 8 hour period. All the procedures can be carried out for 25 minutes and require only minimum of laboratory equipment. In patients the quality of scan images have been excellent with good resolution, when using 1.5 mCi doses. No side effects have been observed. The ^{113m}In-SMAA as a new radiopharmaceutical proved to be useful for routine clinical investigations. (auth)

13058 CLINICAL EXPERIENCE WITH ^{99m}Tc-LABELED PYROPHOSPHATE AND POLYPHOSPHATE FOR DETECTION OF BONE PATHOLOGY. Pfannenstiel, P.; Henne, W.; Pixberg, H. U. (Deutsche Klinik fuer Diagnostik, Wiesbaden, Ger.). Radiobiol.-Radiother.; 15: No. 1, 141-153(1974). (In German).

Recently developed ^{99m}Tc-labeled phosphate compounds, polyphosphate in particular, have led to widespread use of bone scanning. Over 350 patients have been studied during the last year at our institution. ^{99m}Tc-Polyphosphate appeared to be the most favorable agent considering ease of preparation, stability, and quality of scans. Our camera studies have proven to be superior to the rectilinear scans. Large amounts of radioactivity can be given to the patient providing a high level of statistical significance. Thus an excellent delineation of the skeletal anatomy was observed. Because of the good physical characteristics, availability, and superior scan quality, ^{99m}Tc-phosphate-complexes should be the radiopharmaceuticals of choice for detection of bone pathology, including inflammatory disease of the joints. In addition, the bone scan represents a sensitive means of assessing response of therapy and progression of skeletal disease. (auth)

13059 BONE SCINTIGRAPHY WITH DIGITAL DATA PROCESSING. Georgi, P.; Lorenz, J. W. (Deutsche Krebsforschungszentrums, Heidelberg). Radiobiol.-Radiother.; 15: No. 1, 155-166(1974). (In German).

Animal experimental examinations of the accumulative behavior of osteotropic radionuclides and radiopharmaca ^{18}F, ^{47}Ca, ^{85}Sr, ^{99m}Tc-phosphate compounds, ^{133m}Ba, ^{153}Sm, ^{157}Dy, and ^{177}Lu are reported. ^{18}F and earth alkalies were shown to be most accumulated and to be nearly homogenous in their accumulative behavior. Blood clearance is most rapid for ^{18}F. Based on the experimental results and because of its biological properties ^{18}F is best suited for bone scintigraphy. Results of digital data processing in clinical bone diagnosis are reported. Data were collected by a DEC computer PDP-8 and processed by an IBM computer 360/67. Image processing process implies the following possibilities: flat-phantom correction, interactive analysis (IBM 2240), filtration, analyses of regions of interest, representation of profile and time-activity curves, and automatic analysis of spinal column scintigrams. The diagnostic statement in bone scintigraphy is found to be essentially increased by the use of electronic data processing. (auth)

13060 NUCLEAR MEDICAL EXAMINATIONS OF CALCIUM RESORPTION AND BONE METABOLISM. Sack, H. (Gesamthochschule, Essen). Radiobiol.-Radiother.; 15: No. 1, 167-178 (1974). (In German).

Examinations of calcium metabolism with radioactive isotopes are carried out at a few places only. There a test is represented leading with limited methodical and time expense to results within 10 to 14 days. The choice of available radionuclides and their measurement technical peculiarities are discussed. The level of calcium resorption depends on age, on the calcium amount offered and on the chemical and galenic type of the preparation. Characteristic changes in generalized skeletal diseases can be recognized by the metabolic test. Osteoporosis cannot be diagnosed by this test as it does not imply significant changes in calcium metabolism. On the other hand, secondary types of osteoporosis in hyperthyroidism, hyperparathyroidism, and others are well recognizable. (auth)

13061 BONE MARROW SCINTIGRAPHY WITH ^{99m}Tc-SULFUR RHENIUM COLLOID IN PATIENTS WITH RETOTHELIC SARCOMA. Glaubitt, D.; Schneider, J.; Gerhartz, H. Radiobiol.-Radiother.; 15: No. 1, 179-184(1974). (In German).

In five patients with medicamentously treated retothelic sarcoma bone marrow scintigrams with 10 mCi ^{99m}Tc-sulphur rhenium colloid each were made in the area of the minor pelvis, of the lower lumbar vertebrae, and of the proximal femoral third. One patient showed an increase in radioactivity accumulation, the other patients a decrease. In one patient bone marrow scintigram gave rise to the suspicion of tumor focuses in sacral bone marrow. (auth)

13062 TUMOR SCINTIGRAPHY WITH ^{67}Ga-CITRATE. Altenbrunn, H. J.; Markwardt, J.; Wirbatz, W. Radiobiol.-Radiother.; 15: No. 1, 203-212(1974). (In German).

Although the reasons of preferred ^{67}Ga concentration in the majority of malignant tumors are only partly clarified, gallium scintigraphy virtually yields advantages in tumor and metastasis diagnosis. In 84% of the patients with malignant processes a ^{67}Ga-citrate concentration in the tumor was scintigraphically demonstrated (57 out of 68). In 11 out of 68 patients, the tumor could not be demonstrated scintigraphically. Especially tumor demonstration did not succeed following tumor irradiation and in smaller, approximately chestnut-sized liver metastases. According to our results, scintigraphy following ^{67}Ga-citrate application is apparently suitable for the differential diagnosis of benign and malignant processes. In an abnormal concentration of this radiopharmacon a histological assurance is to be aspired to because in such a case a malignant degeneration has to be taken into consideration. (auth)

13063 PORTAL BLOOD FLOW MEASURING METHOD WITH ^{133}Xe. Buchali, K.; Zimmermann, H. B.; Schneider, G.; Strangfeld, D. Radiobiol.-Radiother.; 15: No. 1, 213-216(1974). (In German).

A method for determining portal liver blood flow with ^{133}Xe is described, the radioactivity being injected into the spleen. Appearance times above the heart can give information about hemodynamically effective shunts. Normal portal blood flow was determined to be 104 (69 to 156) ml/100 g · min. Splenic blood flow after arterial xenon injection yields on the average 68.5 ml/100 g · min. In liver cirrhoses arterial and portal liver blood flow is decreased independently of each other. A decrease in liver blood flow is not assured. (auth)

13064 PHARMACOKINETICS OF NEW RADIOIODINE-LABELED AROMATIC ACIDS. Deckart, H.; Schmidt, H. E.; Herz-

mann, H.; Blottner, A. Radiobiol.-Radiother.; 15: No. 1, 27-38 (1974). (In German).

Known detoxication reactions of body-foreign substances by coupling to body-own substances taking place in organism, such as detoxication of incorporated benzoic acid by pairing with glycocol under formation of hippuric acid, served as a model for radiochemical and pharmacokinetic examinations to new compounds for nuclear medical renal function and localization diagnosis. Under this aim different aromatic carbonic acids (salicylic acid, sulphosalicylic acid, O-iodo-phenylacetic acid, O-iodo-phenaceturic acid) as well as sulphanilic acid and 9 sulphonamides with different substituents of amide nitrogen (acetyl-, pyrimidine-, thiadiazol-, carbamine-, and pyrazol group) were prepared and labelled with ^{131}iodine, respectively, and pharmacologically examined. With respect to iodine stability all given compounds did not show differences in vitro and in vivo compared with the well-known preparations O-^{131}iodo-benzoic acid and O-^{131}iodo-hippuric acid. (auth)

13065 METHOD OF PRODUCTION OF ^{99m}Tc-POLYPHOSPHATE FOR BONE SCINTIGRAPHY AND THE USE IN CLINICAL DIAGNOSTIC OF METASTASES. Schwartz, K. D.; Berger, M.; Meyer, H.; Ausborn, D. Radiobiol.-Radiother.; 15: No. 1, 63-66 (1974). (In German).

A method for the preparation of ^{99m}Tc-labeled polyphosphate for skeletal scintigraphy is described being easily applicable in the isotope laboratory. For the production of 10 dry ampoules of the preparation for one examination each 500 mg/10 ml $Na_4P_2O_7 \cdot 10\ H_2O$ are mixed with a freshly prepared solution of 10 mg $SnCl_2 \cdot 2\ H_2O$ in 2 ml 1n HCl, filled into special ampoules, evaporated at 700 to 800°C and sealed sterilely. The suitability of the preparation for clinical diagnostics is confirmed by means of results of about 50 examinations. (auth)

13066 REPORT OF THE NATIONAL PITUITARY AGENCY. Collaborative Study of the Radioimmunoassay of Human Prolactin. Aubert, M. L.; Becker, R. L.; Saxena, B. B.; Raiti, S. (National Pituitary Agency, Baltimore). J. Clin. Endocrinol. Metab.; 38: No. 6, 1115-1120(Jun 1974).

A collaborative study of the reagents for the radioimmunoassay of human prolactin (hPRL) to be distributed by The National Institute of Arthritis, Metabolism and Digestive Diseases was carried out. Each group applied the radioimmunoassay techniques and conditions currently used in their laboratory. The Lewis and Friesen hPRL tracers behaved identically though the former produced a more sensitive assay. Both hormones were iodinated satisfactorily by the Chloramine T method. The Friesen antiserum was more sensitive than the SLV antiserum. Similar results were obtained for each of the plasma samples supplied in the homologous and heterologous systems. The results obtained confirmed the reports of the investigators who donated the reagents. (auth)

13067 FALSELY POSITIVE BOVINE TSH RADIOIMMUNOASSAY RESPONSES IN SERA FROM PATIENTS WITH THYROID CANCER. Greenspan, F. S.; Lew, W.; Okerlund, M. D.; Lowenstein, J. M. (Univ. of California, San Francisco). J. Clin. Endocrinol. Metab.; 38: No. 6, 1121-1124(Jun 1974).

We previously reported a high incidence of material similar in immunological activity to bovine TSH in patients with thyroid cancer. Further investigation has revealed that these results were falsely positive. They can be attributed in part to previous immunization of some patients with injections of bovine TSH, and in part to nonspecific protein effects on the solid-phase radioimmunoassay system, which requires not only a constant protein concentration, but also a constant protein composition of the reaction medium. (auth)

MATERIALS

13068 (LBL-2585) NON-CONVENTIONAL ELECTRON MICROSCOPY IN SMALL DEFECT CHARACTERIZATION. Seshan, K. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Feb 1974. Contract W-7405-eng-48. 2p. (CONF-740803-2). Dep. NTIS $4.00.

From thirty-second annual meeting of the electron microscopy society and exhibition; St. Louis, Missouri, USA (13 Aug 1974).

Two nonconventional imaging techniques which yield narrow images (20-40 Å) are applied to small defects: symmetric weak-beam bright field and weak-beam condition with two S_g values. (DLC)

13069 (N-73-32467) APPLICATION OF DIFFUSION BARRIERS TO THE REFRACTORY FIBERS OF TUNGSTEN, NIOBIUM, CARBON, AND ALUMINUM OXIDE. Technical Report, May 1972—June 1973. Douglas, F. C.; Paradis, E. L.; Veltri, R. D. (United Aircraft Corp., East Hartford, Conn. (USA). Research Labs.). Sep 1973. 61p. (NASA-CR-134466). NTIS $5.50.

A radio frequency powered ion-plating system was used to plate protective layers of refractory oxides and carbide onto high-strength fiber substrates. Subsequent overplating of these combinations with nickel and titanium was made to determine the effectiveness of such barrier layers in preventing diffusion of the overcoat metal into the fibers with consequent loss of fiber strength. Four substrates, five coatings, and two metal matrix materials were employed for a total of forty material combinations. The substrates were tungsten, niobium, NASA-Hough carbon, and Tyco sapphire. The diffusion-barrier coatings were aluminum oxide, yttrium oxide, titanium carbide, tungsten carbide with 14% cobalt addition, and zirconium carbide. The metal matrix materials were IN 600 nickel and Ti 6/4 titanium. Adhesion of the coatings to all substrates was good except for the NASA-Hough carbon, where flaking off of the oxide coatings in particular was observed. (auth)

13070 (NASA-SP-5922(2)) MATERIAL CUTTING, SHAPING, AND FORMING. A Compilation. (National Aeronautics and Space Administration, Washington, D. C. (USA)). [nd]. 29p. Dep. NTIS $1.00.

This compilation is part of the NASA-AEC technology utilization program for applications outside the aerospace and nuclear communities. Of the 29 techniques described, two are in NSA scope: brazing of contoured Be honeycomb panels, and production of ceramic structures from ultrapure BeO. (DLC)

13071 HANDBOOK OF PRECISION ENGINEERING. Volume 2. Materials. Davidson, A. (ed.). Philips Technical Library. New York; McGraw-Hill Book Company (1970). 450p.

This volume deals with the materials used in the design of fine mechanisms. The 11 chapters deal respectively with: metals, plastics and rubbers, glass, ceramics, precious materials, paper, paints, adhesives, lubricants, process materials, and cutting fluids. A separate abstract was prepared for the chapter on metals. (DLC)

13072 ROLE OF VAPORIZATION STUDIES AND MASS SPECTROMETRY IN THE THERMODYNAMICS AND PHASE RELATIONS OF NUCLEAR MATERIALS. Gilles, P. W. (Univ. of Kansas, Lawrence). J. Nucl. Mater.; 51: No. 1, 12-16(May 1974).

The thermodynamics and phase relations of nuclear materials can be conveniently and powerfully studied by high-temperature vaporization investigations, especially if mass spectrometric techniques are incorporated. The physical principles of importance in high-temperature vaporization experiments and the use and limitations of conventional and mass spectrometric techniques are discussed. A vaporization study gives thermodynamic information about condensed materials and gases if equilibrium exists during the measurements. The course of a vaporization study leading to equilibrium values is described. The mass spectrometer has not been excelled for the identification of species, for rapid measurements of abundances, and for measurements of the temperature coefficients of the intensities of all the species. The instrument may be used for the investigation of vaporization reactions, for the study of reactions involving only gases in equilibrium with one another, and for the measurement of the chemical potentials of the individual components in a chemical system throughout wide composition ranges. (auth)

13073 SURFACE AND SIZE EFFECTS IN THE SPECIFIC HEAT OF SOLIDS. Novotny, V. J. Toronto; Univ. of Toronto (1972). National Library of Canada, Ottawa.

Thesis (Ph. D.).

The specific heats of small metal particles and porous glasses were investigated at low temperatures from 1.5 to 15°K in order to assess the effect of the surface on the thermodynamic properties of solids. The specific heat of bulk lead in the superconducting state was examined in an attempt to settle the differences between previous measurements and to provide the basis for the direct determination of the changes in the specific heat of small lead particles. Specific heat enhancements were observed in 22, 37, and 60 Å lead particles and in 22 Å indium particles. The lattice enhancements resulting from the low-frequency surface modes not present in the bulk crystal do not obey T^3 dependence even over a limited temperature range. Moreover the amount of enhancements increases less rapidly with the surface area than expected. Qualitative disagreement with semi-infinite model predictions indicate the limitations and inadequacy of the theories mainly for the small sizes. The falloff of the enhancement at the lowest temperatures is interpreted as the first observation of the effect of finite size on the lattice specific heat. Experimental and theoretical estimates of falloffs due to the removal of low-frequency modes are attempted. The measurements also permit the estimate of probable decreases in the superconducting electronic specific heat of small lead particles. The suppression could be caused by decreases in the electronic density of states at the Fermi surface and/or by the increases of the superconducting energy gap. The striking increase in the specific heat discontinuity at the enhanced transition temperature of 22 Å indium could have resulted from the changes in the electronic spectrum but owing to the reported anomaly in the bulk specific heat of indium, the lattice effects on the discontinuity cannot be ruled out. The transition temperatures determined in the specific heat measurements were compared with the mutual inductance technique results and generally agreement was found. A simple model is used to estimate the average of the square of the phonon frequency and to evaluate the effect of softer phonons on the transition temperature of the small particle superconductors. In order to explain the prevailing discrepancies the effects of size quantization on the electronic spectrum and the coupling between particles are pointed out. The observed enhancement in the specific heat of empty porous glasses is attributed to the low frequency surface modes probably present in amorphous solids with large surface areas. The lower limits of the thermal diffusivities of porous glasses and systems of small metal particles in glasses are also determined. (Diss. Abstr. Int., B)

Ceramics and Cermets

Refer also to abstracts 12313, 13175, 13211, 13242, 13253, 13259, 13260, 13774, 14635, and 14639.

13074 (AD-771002) LUMINESCENCE STUDIES OF POINT DEFECTS IN SELECTED OXIDES. Final Report. Land, P. L. (Aerospace Medical Research Lab. (6570th), Wright-Patterson AFB, Ohio (USA)). Aug 1973. 11p. (ARL-73-145). NTIS $2.75.

The investigation is centered on the study of thermoluminescence, fluorescence, and coloration of metal oxides resulting from included point defects. The major accomplishments are summarized and publications generated under this effort are referenced. (GRA)

13075 (ANL-8077) IN-GLOVEBOX ION MILLING OF CERAMIC SPECIMENS FOR TRANSMISSION ELECTRON MICROSCOPY. Packan, N. H. (Argonne National Lab., Ill. (USA)). Mar 1974. Contract W-31-109-Eng-38. 20p. AT.

An ion-milling apparatus was assembled in a glovebox for the preparation of plutonium-bearing fuel materials (or other ceramics) into thin-foil electron-microscopy specimens. This report describes the components of the system, with emphasis on modifications made to facilitate glovebox operation. Procedures are outlined for preliminary sample preparation by special grinding techniques, ion-milling operation, final surface treatment, handling of the thinned foils, and maintenance of the apparatus. Electron micrographs of ion-thinned UO_2 are presented, with special reference to the recognition of artifacts caused by the ion milling. (10 fig) (auth)

13076 (BNWL-tr-118) STABILITY OF THE MONOCLINIC MODIFICATION OF THE SESQUIOXIDE OF AMERICIUM AND EUROPIUM. Berndt, U.; Tanamas, R.; Maier, D.; Keller, C. Translated by B. G. Russell from Inorg. Nucl. Chem. Lett.; 10: 315-321(1974). 6p. Dep. NTIS $4.00.

X-ray study of highly purified $AmO_{1.5}$ showed that B–$AmO_{1.5}$ does not exist in pure form, but can be stabilized by small amounts of foreign oxides. C–$EuO_{1.5}$ was proven to be the thermodynamically stable modification at room temperature and 800 to 1050°C. B–$EuO_{1.5}$ is no true low-temperature modification; rather, it is formed topochemically and then exists as a metastable phase up to 1050°C. (DLC)

13077 (GEAP-12489) THERMODYNAMIC DATA PROGRAM INVOLVING PLUTONIA AND URANIA AT HIGH TEMPERATURES. Quarterly Report No. 26, November 1, 1973–January 31, 1974. Aitken, E. A.; Adamson, M. G.; Evans, S. K. (General Electric Co., Pleasanton, Calif. (USA). Vallecitos Nuclear Center). Feb 1974. Contract AT(04-3)-893. 41p. Dep. NTIS $4.00.

Progress is reported on the continuing scope of work related to fission product–cladding chemical interaction, sodium–fuel interaction, and oxygen and plutonium–uranium redistribution in temperature gradients. (auth)

13078 (KFK-1814) DESIGN, IRRADIATION, AND EXAMINATION OF UO_2–PuO_2 FUEL PINS IN THE TEST DRF-304. Kummerer, K.; Geithoff, D. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Material- und Festkoerperforschung; Kernforschungszentrum Karlsruhe (F. R. Germany). Projekt Schneller Brueter). Jan 1974. 140p. (In German). INIS.

Within the fuel pin development for fast breeder reactors the irradiation experiment DFR-304 comprises the irradiation of 3 fuel pins with UO_2–PuO_2 fuel and a stainless steel cladding in the fast flux of the NaK cooled Dounreay Fast Reactor. The design of the pins with respect of composition and geometry as well as of operational conditions was to some extent representative for a prototype fast reactor like SNR-300. This irradiation experiment primarily is to be considered as a precursor of the bundle irradiation DFR-350, which afterwards took place in the central hexagon of the DFR. The 3 pins were assembled in a so-called "trefoil" which was inserted into a fuel position of the DFR. The maximum linear rod power at beginning of irradiation was a little above 500 watts/cm. The (calculated) maximum temperature at the clad inner surface was about 670°C. The local maximum burnup of 56,000 MWd/t metal surpassed the target burnup slightly without any pin irregularity. This report is a documentation of the whole irradiation experiment and includes all data and facts concerning the experimental objectives, the pin design and specifications, the fabrication of the pins and the pre-irradiational tests, the irradiation history and, finally, the nondestructive and destructive post irradiation examination. (GE)

13079 (LA-5524) HELIUM RELEASE AND MICROSTRUCTURAL CHANGES IN $^{238}PuO_2$. Mueller, B. A.; Rohr, D. D.; Mulford, R. N. R. (Los Alamos Scientific Lab., N. Mex. (USA)). Jan 1974. Contract W-7405-eng-36. 17p. Dep. NTIS $4.00.

Helium release rates and microstructural changes during isothermal heat treatments were determined for $^{238}PuO_2$ specimens. Grain boundary bubbles formed in most of the specimens under the conditions studied. Swelling of the ceramic was minimal and was attributed to the bubbles observed in the grain boundaries. The helium release data were fitted with a classical diffusion model for comparison with previous data. (auth)

13080 (LA-5582-PR) ADVANCED PLUTONIUM FUELS PROGRAM. Quarterly Report, October 1–December 31, 1973. Baker, R. D. (comp.). (Los Alamos Scientific Lab., N. Mex. (USA)). Apr 1974. Contract W-7405-eng-36. 33p. Dep. NTIS $4.00.

Progress is reported in: examination of fast reactor fuels, high-performance LMFBR fuel materials, and FBR quality assurance standards and methods. (DLC)

13081 (N-73-32530) FISSION-GAS-RELEASE RATES FROM IRRADIATED URANIUM NITRIDE SPECIMENS. Weinstein, M. B.; Kirchgessner, T. A.; Tambling, T. N. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). Oct 1974. 24p. (NASA-TM-X-2890; E-7504). NTIS $2.75.

Fission-gas-release rates from two 93 percent dense UN specimens were measured using a sweep gas facility. Specimen burnup rates averaged .0045 and .0032 percent/h, and the specimen temperatures ranged from 425 to 1323°K and from 552 to 1502°K, respectively. Burnups up to 7.8 percent were achieved. Fission-gas-release rates first decreased then increased with burnup. Extensive interconnected intergranular porosity formed in the specimen operated at over 1500°K. Release rate variation with both burnup and temperature agreed with previous irradiation test results. (STAR)

13082 (ORNL-4969) MATHEMATICAL DESCRIPTION OF FISSION PRODUCT TRANSPORT IN COATED PARTICLES DURING POSTIRRADIATION ANNEALS. Evans, R. B. III; Morgan, M. T. (Oak Ridge National Lab., Tenn. (USA)). Jun 1974. 45p. Dep. NTIS $5.45.

This report is concerned with several integrated forms of the diffusion equation that might be used to interpret and correlate cesium (and perhaps strontium) release data obtained from postirradiation anneals of pyrocarbon-coated fuel particles. Emphasis is placed on the role of the initial and boundary conditions as influenced by source concentration levels, permanent trapping in the source, and partition coefficients between the source and coating. It is assumed that release rates are controlled by the source potential and the diffusivity of the coating (with and without an external film or evaporation coefficient). A review of the equations, coupled with considerations of correlation procedures, indicates the need for complementary experiments that will give independent measurements of the trapped fraction and boundary concentrations. (auth)

13083 (Y-DA-2763) STATUS REPORT ON DEVELOPMENT AND EVALUATION OF NERVA FUEL ELEMENT MATRICES. Lawton, R. G.; Napier, J. M.; Prince, W. R.; Rowley, J. C. (Oak Ridge Y-12 Plant, Tenn. (USA)). 9 May 1969. Contract W-7405-eng-26. 98p. Dep. NTIS $8.00.

The present graphite–uranium matrix has a coefficient of thermal expansion (CTE) value of 3.3×10^{-6} in/in°C; when coated with niobium carbide which has a nominal CTE value of 7.4×10^{-6} in/in°C, open cracks in the niobium carbide cladding are present at temperatures less than the deposition temperature of the coating. A program was initiated to produce NERVA fueled graphite elements having an increased CTE value. Phase I, which has been completed, involved the grinding of a series of commercial graphites; the material was then fabricated into unloaded elements which had a CTE that varied from 3.3×10^{-6} to 6.5×10^{-6} in/in°C. The thermal stress resistance was also determined. In Phase II, the variables studied included: various graphite flours, the use of Thermax carbon black, and the effects of a nongraphitizing binder. A description of the available fabrication techniques, and listing of the physical properties and thermal stress resistance data are included. It is concluded that elements having an increased CTE value can be manufactured. Three graphites (Spear SX5, Gilsonite, and Poco AXM) were purchased, ground, and are being evaluated; one of these materials will be used to fabricate the fuel elements for the Pewee 2 case. (DLC)

13084 (Y-DA-3194) MELTING POINTS OF COATINGS OF NERVA FUEL ELEMENTS. Napier, J. M.; Bennett, R. K. (Oak Ridge Y-12 Plant, Tenn. (USA)). 10 Dec 1969. Contract W-7405-eng-26. 97p. Dep. NTIS $8.00.

The present NERVA fuel element matrix contains a mixture consisting of filler particles of graphite, a glassy carbon binder, and pyrocarbon-coated uranium dicarbide beads. The gas-passage bores are vapor coated with either niobium carbide or zirconium carbide, or a combination of these carbides. The melting point of the coatings in contact with the matrix was studied. Zirconium and niobium carbide-coated elements, which do not contain the uranium dicarbide particles, were heated to 2,750°C for one hour in an argon atmosphere without melting the coating; zirconium and niobium carbide coatings in uranium-loaded elements melted at 2,400 to 2,500°C. Addition of a molybdenum overcoat on top of a niobium carbide film in a nonuranium element had a melted coating after the 2,600°C heat treatment. The addition of a thin pyrocarbon film on top of the uranium-loaded matrix and beneath the metal carbide layers may have raised the melting point of the coatings by an estimated 50°C. (auth)

13085 THERMODYNAMIC PROPERTIES OF ZrO (g) AND HfO (g); A CRITICAL EXAMINATION OF ISOMOLECULAR OXYGEN-EXCHANGE REACTIONS. Ackermann, R.J.; Rauh, E.G. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). J. Chem. Phys. 60: No. 6, 2266-2271 (15 Mar 1974).

The thermodynamic properties of ZrO(g) and HfO(g) have been determined by mass-spectrometric studies of five isomolecular oxygen-exchange reactions of the type $M(g) + M'O(g) = MO(g) + M'(g)$ involving the gaseous atoms and monoxides of yttrium and thorium. Third law values of the standard free energies of formation over the temperature range 2000–2800 K are adequately (within 2%) expressed by the linear equations $\Delta G°_f(ZrO,g) = 130\,40 - 16.04T$, $\Delta G°_f(HfO,g) = 9930 - 14.68T$. Uncertainties of ± 1 kcal mol^{-1} are estimated. Third law analyses of the data yield the enthalpies of formation at absolute zero, $\Delta H°_0(ZrO,g) = 21.4$, and $\Delta H°_0(HfO,g) = 18.5$ kcal mol^{-1}, and the dissociation energies at absolute zero, $D_0(ZrO) = 180.7$, and $D_0(HfO) = 188.9$ kcal mol^{-1}, with uncertainties of 1–2 kcal mol^{-1}. The equilibrium constants for the isomolecular reactions in this and in previous studies were obtained from ion currents and relative instrumental sensitivities that were approximated from the mean square

radii of the gaseous atoms and the squares of the interatomic distances of the gaseous monoxides; the use of these parameters was shown to improve the closure among several thermodynamic cycles by as much as 2 kcal mol^{-1}. (auth)

13086 TEMPERATURE DEPENDENCE OF THE ISOTHERMAL COMPRESSIBILITY OF BORON TRIOXIDE. Bucaro, J.A.; Dardy, H.D. (Naval Research Laboratory, Washington, D.C. 20375). J. Chem. Phys. 60: No. 6, 2559-2560 (15 Mar 1974).

Light scattering spectra were obtained in a B_2O_3 glass melt using an argon ion laser. From the spectra, the Landau–Placzek ratio R_p was calculated. The isothermal compressibility was related to the Landau–Placzek ratio and was deduced from the measured R_p. At higher temeperatures, the measured isothermal compressibility agreed well with the prediction of the degenerate excited state model of Leidecker et al. (AIP).

13087 NUCLEAR MAGNETIC RESONANCE STUDY OF THE TRANSITION METAL MONOBORIDES. II. NUCLEAR ELECTRIC QUADRUPOLE AND MAGNETIC SHIFT PARAMETERS OF THE METAL NUCLEI IN VB, CoB, AND NbB. Creel, R.B.; Segel, S.L. (Department of Physics, Queens University, Kingston, Ontario, Canada); Schoenberger, R.J.; Barnes, R.G.; Torgeson, D.R. J. Chem. Phys. 60: No. 6, 2310-2322 (15 Mar 1974).

Measurements are reported of the nuclear electric quadrupole interaction parameters (coupling constant and asymmetry) and the several anisotropic Knight shift parameters of the ^{51}V, ^{59}Co, and ^{93}Nb nuclear magnetic resonance spectra in VB, CoB, and NbB monoborides, respectively. A detailed account is given of the method of extracting these parameters from the experimental spectra. The quadrupole coupling constants and asymmetry parameters are ^{51}VB, 1.75 MHz, 0.95; ^{59}CoB, 25.2 MHz, 0.74; and ^{93}NbB, 20.4 MHz, 0.065. The isotropic components of the Knight shifts are all positive: ^{51}VB, 0.32%; ^{59}CoB, 0.69%; and ^{93}NbB, 0.24%. Despite the close similarity in the structures of these compounds, neither the quadrupole nor Knight shift parameters scale in a simple manner with the nuclear properties. Thus, even in the cases of VB and NbB, it appears that a rigid-band type approximation furnishes a poor description of the actual changes in the electronic structure. (auth)

13088 CHARACTERISTIC ENERGY GAIN AND LOSS, DOUBLE IONIZATION, AND IONIZATION LOSS EVENTS IN Be AND BeO SECONDARY ELECTRON SPECTRA. Jenkins, L. H.; Zehner, D. M.; Chung, M. F. (Oak Ridge National Lab., TN). Surface Sci.; 38: No. 2, 327-340(Jul 1973).

Two satellite peaks have been observed on the high energy side of the Be KVV Auger peak. The lower energy satellite is attributed to coupling of energy from bulk plasmon de-excitations with Auger electrons, and the higher energy event to Auger electrons ejected from Be atoms with doubly ionized K levels. Following oxidation, the ionization loss spectra of BeO were observed to have structure which is interpreted as being related to the density of unfilled electron states above the BeO valence band. In addition, the characteristic loss and the low energy ("true secondary") spectra of Be and BeO were determined. Peaks in these spectra are discussed in terms of characteristic energies related to excited electron states in the solids. (auth)

13089 POLARIZED RAMAN SPECTRA OF FERROELECTRIC AND NONFERROELECTRIC POTASSIUM LITHIUM NIOBATE. Siapkas, D. (King's Coll., London); Clarke, R. Phys. Status Solidi (b); 62: No. 1, 43-49(1 Mar 1974).

The polarized Raman spectra of two potassium lithium niobate compositions are presented. The first, a nearly stoichiometric ferroelectric version, $K_{5.9}Li_{3.8}Nb_{10}O_{30}$, exhibits a strongly temperature dependent $A_1(z)$ spectrum near the Curie point. This is held to be indicative of soft mode behavior. The relationship between structural, dielectric, and Raman measurements in this material is discussed. Measurements of the integrated intensity of the $A_1(z)$ modes, as a function of temperature, are presented and an estimation of the room-temperature spontaneous polarization is deduced. The $A_1(z)$ modes persist for tens of degrees above the Curie point indicating that there are regions of nonzero polarization within the crystal above the Curie point. No temperature dependence of the $A_1(z)$ mode frequencies is observed in $K_{5.0}Li_{2.4}Nb_{10}O_{30}$, a closely related non-ferroelectric composition. (auth)

13090 CRYSTAL FIELD DETERMINATION IN RARE EARTH OXYSULFIDES. I. Optical Experiments for Tb^{3+} ION. Rossat-Mignod, J. (CEN, Grenoble, France); Souillat, J. C.; Quezel, G. Phys. Status Solidi (b); 62: No. 1, 223-233(1 Mar 1974).

The crystalline electric field (CEF) acting on a Tb^{3+} ion in rare-earth oxysulfides has been determined. By analyzing fluorescence spectra of Y_2O_2S : 1% Tb^{3+}, it is possible to obtain the energy levels of the ^7F_j (J = 1 to 6) manifolds of Tb^{3+} in this host and therefore the CEF Hamiltonian of C_{3v} symmetry. In order to explain the particular magnetization processes in Tb_2O_2S, particular attention has been paid to the ground state. It has been found that the ground state consists of four levels lying very close to one another (0, 6, 15, 26 cm^{-1}). Both the direction and the value of the magnetic moment calculated according to this level scheme agree well with neutron diffraction data. (auth)

13091 MAGNETIC CIRCULAR DICHROISM OF UO_2 IN THE 13000–17000 CM-ANTIL RANGE. Vance, E. R. (Australian National Univ., Canberra). J. Phys., C (London); 7: No. 9, L185-L187(7 May 1974).

Absorption and magnetic circular dichroism spectra of single crystal UO_2 show that all the readily observable transitions in the 13000 to 17000 cm^{-1} range involve electronic systems with singlet ground states. The absorption peaks appear to be intrinsic to UO_2, and due to excitons rather than single-ion $f \rightarrow f$ transitions. (auth)

13092 EFFECT OF POROSITY AND STOICHIOMETRY ON THE THERMAL CONDUCTIVITY OF URANIUM DIOXIDE. Hobson, I. C.; Taylor, R.; Ainscough, J. B. (Univ. of Manchester, Eng.). J. Phys., D (London); 7: No. 7, 1003-1015(1 May 1974).

Measurements have been made using a flash thermal diffusivity technique from 550 to 2500°K on a range of well-characterized materials. Data are reported on specimens of five different porosity levels, samples in which porosity has been redistributed, and specimens, initially of two different porosity levels, oxidized to three different hyperstoichiometries. The data are discussed in the light of current theories, and it is shown that the porosity correction term is temperature-dependent. The conductivity at any porosity P over the temperature (T) range 500 to 1600°K is given by $\lambda_p(W\,m^{-1}\,K^{-1}) = [0.0433 + 0.355\,P + (2.01 + 1.47\,P) \times 10^{-4}T]^{-1}$. This temperature-dependent porosity correction is shown to be related to total porosity, and it is suggested that this is due to additional vacancy scattering. An expression is derived for the additional phonon scattering due to interstitial oxygen atoms up to small hyperstoichiometry levels. Finally, the deviation from linearity at high temperatures is shown to be due to an electronic contribution to the total thermal conductivity. (auth)

13093 OXYGEN DIFFUSION STUDIES USING NUCLEAR REACTIONS. Calvert, J. M.; Derry, D. J.; Lees, D. G. (Univ. of Manchester, Eng.). J. Phys., D (London); 7: No. 7, 940-953 (1 May 1974).

The techniques available for oxygen diffusion measurements are summarized and the usefulness of using nuclear techniques is illustrated. In the present work, the mass-18 isotope of oxygen is used as the diffusing species and its concentration distribution is subsequently explored using the 1.763 MeV resonance in the $^{18}O(p,\alpha)^{15}N$ reaction. The yield from the resonance gives a measure of ^{18}O concentration, and depth is explored by measuring at different energies of the incident protons. Variations in the technique have been used. Various methods of analyzing the data have been explored and the preferred one is that which makes allowance for the various spreading factors which contribute to the observed α-particle spectrum. Measurements are quoted for the ^{18}O self-diffusion coefficient in a TiO_2 specimen showing that they have good reproducibility and are consistent with those of other observers. (auth)

13094 DOSE DEPENDENCE OF THERMOLUMINESCENCE PEAKS. Kristianpoller, N.; Chen, R.; Israeli, M. (Tel Aviv Univ., Israel). J. Phys., D (London); 7: No. 7, 1063-1072(1 May 1974).

The dependence on the excitation dose of the maximum thermoluminescence intensity as well as of the peak temperature are investigated theoretically. It is shown that certain irregularities of the dose dependences can be explained by assuming the existence of a trapping level, the transition into which competes with the retrapping and recombination of the free carriers. By numerical solution of the appropriate equations, it is demonstrated that the maximum thermoluminescence intensity may depend superlinearly on the excitation dose. The power of the dose dependence was found to be 2 under certain circumstances at low doses, and reached even higher values before saturation of the competing level. The maximum temperature sometimes behaved in an unusual way; namely, it increased with increasing dose. The relation between the area under a glow peak and its maximum intensity is also studied; it is shown that the latter can usually serve as a measure for the former. This finding is of practical importance, especially in thermoluminescent dosimetry, since the evaluation of the maximum intensity is obviously more convenient than that of the area. (auth)

13095 STUDY OF THE ENTHALPY AND SPECIFIC HEAT OF MATERIALS BASED ON NIOBIUM CARBIDE AT HIGH TEMPERATURES. Sheindlin, A.E.; Belevich, I.S.; Kozhevnikov, I.G. (High-Temperature Institute, Academy of Sciences of the USSR). High Temp. 11: No. 1, 75-78 (Sept 1973).

The results of a study of the enthalpy and specific heat of niobium carbide with various Nb:C ratios are reported. The measurements were made by the method of mixing in the temperature range 300–3500 K. Equations representing the temperature dependence of the enthalpy and specific heat are given. The error in measuring the enthalpy was ±1.5%. (auth)

13096 RADIATION-INDUCED ELECTRICAL CONDUCTIVITY IN ALUMINA. Iyengar, K. P. R. Manhatten, KS; Kansas State University (1973). University Microfilms.

Thesis (Ph. D.).

Radiation effects on the electrical conductivity of bulk alumina were investigated using ^{60}Co gamma rays and Coors Porcelain Co., Golden, Colorado, alumina specimens of grades AD998, AD94, and AD85 (grade indicates Al_2O_3 content, e.g., AD998: 99.8% Al_2O_3). Static and enradiant direct current electrical conductivities were measured using ASTM prescribed three-terminal guard-electrode techniques. Currents in the range 10^{-14} to 10^{-9} A were measured using an electrometer operational amplifier. Post-irradiation transient electrical conductivities were measured under varying conditions of radiation exposure and applied voltage. (Diss. Abstr. Int., B)

13097 STUDY OF METAL–OXYGEN SOLID SOLUTIONS UTILIZING SOLID-ELECTROLYTIC CELLS. Nickerson, W. J. Urbana, IL; University of Illinois (1973). 129p. University Microfilms Order No. 74-5648.

Thesis (Ph. D.).

A thermodynamic study was made of the Nb–O, Ta–O, Nb–O–N, and Ta–O–N systems utilizing the solid state galvanic cell technique. Investigations were made over the temperature range 850 to 1275°C in a pressure range of 10^{-7} to 10^{-8} torr utilizing a ThO_2/Y_2O_3 electrolyte. Results for the activation energy for diffusion of oxygen in Ni and Nb are reported. The terminal solubility of oxygen in Nb and Ta are determined. Ternary N additions up to about 1.5 at. % are found to have little effect on the oxygen terminal solubility and related thermodynamics. It is concluded that oxygen obeys Henry's law for concentrations up to the terminal solubility. No significant clustering or interactions between interstitial solute atoms are detected in either the binary or ternary systems. Thermodynamic quantities were deduced for the reaction of oxygen going from the gas phase into the solid solution and are compared with similar refractory metal–gas reactions. It is believed that oxygen is bound to the lattice much more tightly than nitrogen, thus reducing the vibrational entropy of oxygen. It is concluded that the absolute entropy for oxygen is basically configurational, whereas nitrogen has a significant vibrational term. Preliminary kinetic data indicate that by measuring emf transients it is possible to determine the activation energy for oxygen diffusion. This study demonstrates the usefulness of this technique for thermodynamic and kinetic studies of systems with low equilibrium oxygen partial pressures. (Diss. Abstr. Int., B)

13098 STUDY OF THE STRUCTURE AND WORK FUNCTION OF BARIUM OXIDE FILMS AND THE Ba–O DOUBLE SYSTEM ON THE (0001) FACE OF RHENIUM. II. Double Ba–O–Re (0001) System. Gorodetskii, D. A.; Knysh, A. N. (Kiev State Univ.). Surface Sci.; 40: No. 3, 651-668(Dec 1973).

The double systems Ba–O–Re (0001) and O–Ba–Re (0001) have been investigated by LEED and contact potential difference techniques. It is shown that the diffraction patterns in both cases were identical to those obtained for BaO films on the (0001) Re face. The analysis of the changes of the work function during the deposition of barium on an oxygen covered substrate suggests the existence of two phase adsorption of oxygen on that crystal face. The results obtained are compared with data for double Li–O–W (110) and Na–O–W (112) systems. (auth)

13099 CALCULATION OF VOLUME AND (110) SURFACE ATOM VIBRATIONS OF III–V COMPOUNDS. Masri, P. (CNRS, Marseille). Surface Sci.; 39: No. 1, 51-60(Aug 1973).

FR.

Analytic expressions are given for the mean-square displacements of volume and (110) surface atoms of III–V compounds. An application is made in the case of GaAs for which experimental data are available. (auth)

13100 WAVELENGTH MODULATION SPECTROSCOPY OF EPITAXIAL IRON GARNET FILMS. Wemple, S. H. (Bell Telephone Labs., Murray Hill, NJ). Surface Sci.; 37: 297-303 (1973).

From proceedings of the first international conference on modulation spectroscopy; Tucson, AZ (23 Nov 1972).

Derivative absorption and reflectance spectra are reported for epitaxially grown iron garnet films and compared with derivative absorption results for bulk yttrium gallium garnet dilutely doped with Fe^{3+}. Results are briefly discussed in terms of crystal field transitions, charge transfer excitons, and charge transfer bands all involving the iron 3d electrons. (auth)

13101 MAGNETIC FIELD-MODULATED MAGNETOREFLECTANCE OF EUROPIUM CHALCOGENIDES. Guentherodt, G.; Wachter, P. (Eidgenoessische Technische Hochschule, Zurich). Surface Sci.; 37: 288-296(Jun 1973).

From proceedings of the first international conference on modulation spectroscopy; Tucson, AZ (23 Nov 1972).

The optical constants of EuO and EuS single crystals have been determined at 300°K by means of a Kramers–Kronig analysis of the reflectivity for photon energies up to 12 eV. For EuS the optical constants have also been determined above and below the Curie temperature in the energy region from 1.5 to 5.7 eV. A first tentative assignment of optical structure to interband transitions has been attempted on the basis of recent orthogonal plane wave (OPW) and earlier augmented plane wave (APW) band structure calculations. For photon energies from 1.2 to 3.8 eV a low magnetic field-modulated magneto-reflectance has been measured using circularly polarized light. By use of the Kramers–Kronig relation for the differential reflectance spectra in conjunction with our data of the optical constants, a detailed analysis of the magnetoreflectance spectra of EuS was carried out for the first time. (auth)

13102 THERMODYNAMIC PROPERTIES OF OXIDE SYSTEMS. IV. Electrolytic Oxygen Permeability of Stabilized Zirconium Dioxide. Samokhval, V. V.; Loiko, G. I.; Vecher, A. A. (Lenin State Univ., Minsk). Russ. J. Phys. Chem. (Engl. Transl.); 47: No. 9, 1283-1285(Sep 1973).

Translated from Zh. Fiz. Khim.; 47: No. 9, 2275-2277(Sep 1973).

From the equation for the molecular flow of oxygen in Wagner's theory of metal oxidation, a relationship was established between the electrolytic oxygen permeation coefficient and the positive-hole conductivity of an arbitrary electrolyte which obeys the condition $P_h \gg p''_{O_2} \gg p'_{O_2}$. The oxygen permeability of the electrolyte $Zr_{0.85}Ca_{0.15}O_{1.85}$ was determined experimentally over the temperature range 1200–1400°C. auth)

13103 NEW DOUBLE OXIDES OF URANIUM AND MOLYBDENUM. Serezhkin, V. N.; Ronami, G. N.; Kovba, L. M.; Trunov, V. K. Zh. Neorg. Khim.; 19: No. 4, 1036-1039(Apr 1974). (In Russian).

The existence of the double oxides of uranium and molybdenum $UMo_{10}O_{32}$ and α-, β-, and γ-$U_3Mo_{20}O_{64}$ was established during the x-radiographic study of the U_3O_8–MoO_2–MoO_3 system. The parameters of the elementary cell of these compounds were determined. (tr-auth)

13104 PHASE STUDY ON SOLID FISSION PRODUCTS, Ba, Sr, AND Zr IN OXIDE FUEL. Koizumi, M. (Power Reactor and Nuclear Fuel Development Corp., Ibaraki, Japan); Satoh, M.; Noro, K. J. Nucl. Mater.; 51: No. 1, 90-94(May 1974).

Behavior of pseudo-fission products (Ba, Sr, and Zr) as oxides in UO_2 has been investigated by means of high-temperature x-ray diffraction and microprobe analysis. Two identifiable compounds were formed as reaction products in the mixed oxides which initially consisted of UO_2, BaO, SrO_2 and ZrO_2 powder. These compounds were present and were identified crystallographically as (Ba, Sr) ZrO_3 and (Ba, Sr)UO_3 after heat treatment of the powders at 1500°C for 30 min. Both compounds are isostructural with perovskite, $CaTiO_3$, and the lattice parameters of both (Ba, Sr)ZrO_3 and (Ba, Sr)UO_3 decrease with increasing content of Sr. (Ba, Sr)UO_3 is decomposed almost completely at 1800°C while (Ba, Sr)ZrO_3 is stable up to 2000°C. The behavior of Ba, Sr, and Zr in fuel under irradiation is discussed. (auth)

13105 THERMODYNAMIC PROPERTIES OF ACTINIDE CARBIDES. Holley, C. E. Jr. (Los Alamos Scientific Lab., NM). J. Nucl. Mater.; 51: No. 1, 36-46(May 1974).

A survey of the literature on the thermodynamic properties of the actinide carbides is presented. For uranium sesquicarbide and plutonium monocarbide there are sufficient new data to permit computation of the relevant thermodynamic functions as a function of temperature. (auth)

13106 RECENT THERMOPHYSICAL DEVELOPMENTS ON NUCLEAR MATERIALS. Westrum, E. F. Jr. (Univ. of Michigan, Ann Arbor). J. Nucl. Mater.; 51: No. 1, 47-57(May 1974).

The current status of chemical thermodynamics of the actinide and lanthanide chalcogenides including high-temperature adiabatic calorimetry of these important compounds (with stress on their electronic, magnetic, order–disorder, disproportionation transitions), as well as the spin-wave magnetic contributions, is reviewed. Schottky anomalies (and the information they yield on crystal-field level splitting), definitive resolution of lattice and magnetic contributions for both first- and second-order phase transitions, and other unusual aspects of phase behavior are considered. Unpublished work on the uranium trioxides, the nonstoichiometric and metastable tetauranium octaoxides, and the uranates, is included. The close parallel between actinide and

lanthanide behavior evidenced by recent unpublished thermal studies on the actinide and lanthanide trichlorides, and hexaborides is emphasized. (auth)

13107 GRAPHITIZATION OF FREE CARBON PRECIPITATING THROUGH THE REACTION OF UC OR UC_2 WITH N_2. Sano, T.; Katsura, M.; Nomura, T. (Osaka Univ.). J. Nucl. Mater.; 51: No. 1, 58-62(May 1974).

It has been found by x-ray diffraction that free carbon produced from reaction of UC or UC_2 with nitrogen gas is not graphite but an amorphous carbon. The degree of graphitization increases with increasing temperature and with decreasing pressure of nitrogen gas. Thermodynamic treatment of these amorphous carbons is discussed in terms of the degree of graphitization. The free energies of the amorphous carbons are calculated to be higher than that of graphite. Furthermore, the influence of the crystal structure of UC or UC_2 on the degree of graphitization is considered qualitatively. (auth)

13108 EFFECT OF NEUTRON IRRADIATION ON THE SINTERING PROCESSES OF BeO POWDER COMPACTS CONTAINING VERY SMALL AMOUNT OF $^{235}UO_2$. Hattori, T. (Chiba Univ., Japan); Suzuki, H. Yogyo Kyokai Shi; 82: No. 3, 160-164 (Mar 1974). (In Japanese).

By using a precipitation method from homogeneous solution, very small amount of $^{235}UO_2$ was homogeneously mixed with less sinterable BeO powder derived from beryllium hydroxide. The BeO–$^{235}UO_2$ (17 ppM) compacts were irradiated by thermal neutrons in a reactor (KUR). The sintering behavior of the compacts was largely different from that of unirradiated compacts. It was found that the post-irradiated compacts began to shrink at higher temperature than the preirradiated compacts. It was supposed that this phenomenon was due to some consolidation of particles caused partially by the irradiation sintering. The post-irradiated compacts sintered rapidly once they began to shrink. It was supposed that this phenomenon was due to enhancement of diffusion of constructing ions when their defects caused by so-called fission fragment damage recovered at high temperature. This shows that internal defects in powder particles affect largely the sinterability of their compacts. Recovery from irradiation damages was effected during relatively short time period at the high temperature used in this experiment. The effects of the irradiation were, therefore, minimized in the later-stage sintering. (auth)

13109 INFLUENCE OF ENERGETICALLY ACTIVE CARBON ON THERMODYNAMICS AND PHASE RELATIONSHIP U–C–N SYSTEM. Katsura, M.; Nomura, T. (Osaka Univ.). J. Nucl. Mater.; 51: No. 1, 63-68(May 1974).

The reactions of UN with graphite and of UN with active carbon have been investigated at 1300 and 1400°C under a variety of pressures of nitrogen gas. Results show that, at fixed pressure, the nitrogen content of the equilibrium UC–UN solid solution formed in the presence of graphite is higher than in the equilibrium UC–UN solid solution formed in the presence of active carbon. A brief thermodynamic argument explains the result in terms of the differing chemical potentials between graphite and active carbon. (auth)

13110 DEPOSITION OF URANIUM-SESQUICARBIDE. Kirihara, T.; Kuno, I.; Matsui, H. (Nagoya Univ., Japan). J. Nucl. Mater.; 51: No. 1, 69-77(May 1974).

Deposition of U_2C_3 from an arc-melted mixture of UC + UC_2 (7.0 ± 0.1 wt % carbon) was examined primarily by the change of electrical resistivity as a function of time at fixed temperatures: 1370, 1440, 1575, and 1650°C. The rate constant of the reaction UC + UC_2 → U_2C_3 was investigated in detail. Growth with one constant dimension, which has been named layer growth, was predominate at 1370°C and during the early stages of growth at higher temperatures. Various growth schemes, which are generally involved, yield various activation energies. The rate constant of the reaction was obtained as $k_n = 1.7 \times 10^{-2} \exp(-n \times 24.67/RT)$ sec^{-1}, where n depends on growth scheme and is usually a number less than 3. The activation energy of 24.67 kcal/mol in the equation was obtained from rate constants with similar n values ($n \approx 3$) at 1440 and 1575°C. (auth)

13111 PHASE RELATIONS AND THERMODYNAMIC PROPERTIES OF THE URANIUM–NITROGEN SYSTEM. Tagawa, H. (Japan Atomic Energy Research Inst., Ibaraki). J. Nucl. Mater.; 51: No. 1, 78-89(May 1974).

The present state of knowledge of the phase relations and thermodynamic properties of the uranium–nitrogen system is given. Emphasis is placed on the nonstoichiometric and thermodynamic properties of uranium sesquinitride. The present paper consists of two parts. The first part is on the phase relations; an equilibrium phase diagram is proposed, and the relationship between structure and lattice parameter for the α-U_2N_3–UN_2 system is shown. The second part deals with thermodynamic properties of UN and α-U_2N_3; the data on decomposition pressures, specific heats, and heats and free energies of formation are summarized and evaluated. (auth)

13112 THERMODYNAMICS APPLIED TO COMPATIBILITY OF UN WITH Ni, Cr, AND Fe. Imoto, S.; Namba, S. (Osaka Univ.). J. Nucl. Mater.; 51: No. 1, 106-111(May 1974).

The compatibility of UN with Ni, Cr and Fe has been studied from the viewpoint of phase equilibrium relationships. The free energies of formation of UNi_3 and U_2CrN_3 have been determined from the measurement of equilibrium pressures of nitrogen for the reactions, $U_2N_3 + 10\ Ni \rightleftharpoons 2UNi_3 + \frac{1}{2}\ N_2$ and $U_2CrN_3 \rightleftharpoons 2\ UN + \frac{1}{3}\ Cr_2N + \frac{1}{4}\ N_2$, respectively, and the values are expressed by $\Delta G(UNi_3) = -67650 + 22.9T$, $\Delta G(U_2CrN_3) = -165900 + 54.64T$. Combination of these and other thermodynamic data with some additional experimental work has generated a log P versus 1/T diagram which shows the phase relationships in the U–N–Ni–Cr system. It is concluded that UN is not compatible with Ni and Cr simultaneously but, for practical purposes, is compatible with Fe below 1400°C. (auth)

13113 NONSTOICHIOMETRY IN URANIUM DIOXIDE. Saito, Y. (Akita Univ., Japan). J. Nucl. Mater.; 51: No. 1, 112-125 (May 1974).

Thermodynamic properties of uranium oxides with O/U atomic ratios between 2.04 and 2.34, principally in the nonstoichiometric UO_{2+x} single-phase region, were determined at temperatures in the range 500 to 1100°C by electromotive force measurements with cells of the type Ni–NiO|ZrO_2(+CaO)|uranium oxide. The relative partial molar free energies of oxygen for the single-phase region UO_{2+x} and the two two-phase coexisting regions UO_{2+x}–U_4O_{9-y} and U_4O_9–U_3O_{8-z} were obtained with adequate precision. Several statistical models for the defect structure of UO_{2+x} have been reviewed. The variation of the relative partial molar entropy of oxygen with composition in the UO_{2+x} phase was derived on the basis of the 2 : 2 : 2 defect complex model proposed from the neutron diffraction study of Willis. The entropies were computed to fit the experimental data assuming that the excess oxygen atoms entered into the fluorite structure in pairs and that the available sites for such oxygen pairs and U^{5+} ions would be partially restricted for occupancy. (auth)

13114 PHASE TRANSITIONS OF U_4O_9. Naito, K. (Nagoya Univ., Japan). J. Nucl. Mater.; 51: No. 1, 126-135(May 1974).

The phase transitions which occur above room temperature in U_4O_9 are reviewed. In the low-temperature transition, the transition temperature varies with O/U ratio from 66 to 97°C, and the variation with O/U ratio in the high-temperature transition is between 530 and 620°C. It was concluded that both transitions are of the order–disorder type involving configurational change of U(IV) and U(V) ions in the U_4O_9 lattice and with oxygens on normal lattice sites entering into interstitial sites through thermal promotion at the transition temperature. These interstitial oxygens intensify the superlattice reflections and also result in lattice contraction. Calorimetry at the low-temperature transition revealed that the entropy change associated with the transition can be divided into two terms: one is due to the order–disorder rearrangement of U(IV) and U(V) ions, the other is due to the displacement of oxygen ions. The phase diagram of U_4O_9 is presented and is based on a combination of electrical conductivity and x-ray data. (auth)

13115 HEAT CAPACITY MEASUREMENTS OF NUCLEAR MATERIALS BY LASER FLASH METHOD. Takahashi, Y. (Tokyo, Univ.). J. Nucl. Mater.; 51: No. 1, 17-23(May 1974).

An improved method of laser flash calorimetry for the precise measurements of heat capacity of nuclear materials is presented. The main points of the improvements are (1) the use of an "absorption disk" and (2) the use of a digital micro-voltmeter and line printer systems for the measurement of sample temperature. Experimental results obtained on a standard sample of alumina at temperatures from 80 to 700°K by the method have a precision of ± 0.5%, which proves the feasibility of the improved method for both low- and high-temperature heat capacity determination of nuclear materials. The results of heat capacity determination by the method on graphites and UP are also presented. (auth)

13116 ELECTRON SPIN RESONANCE OF A $^2S_{\frac{1}{2}}$ STATE CENTER IN IRRADIATED $Pb_4FeSb_6S_{14}$ NATURAL SINGLE CRYSTALS. Teodorescu, M. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 19: No. 3, 267-275(1974).

For the first time, ESR of the ^2S state of the Pb^{3+} ions, produced in $Pb_4FeSb_6S_{14}$ natural single crystals by room temperature, x ray and neutron irradiation is reported, although a considerable previous effort has been devoted to recording the spectra. Three equal-weight samples were used, one of them unirradiated and the other two x-ray and neutron irradiated. All ESR measurements reported were made at room temperature. It seems reasonable to interpret the ESR signal of the

unirradiated sample as due to conduction electrons in metallic lead particles, whereas the ESR spectra of the irradiated samples were attributed to Pb^{3+} ions $^3S_1$ state centers. From the Breit–Rabi formula the hyperfine splitting constant A is determined and then its reduction with regard to the free ion value A_f is discussed. As regards the g-shift, since the unpaired 6s electron of the Pb^{3+} ions is predominantly found in molecular orbitals of the surrounding ligand ions, it supports Watanabe's theory. (auth)

13117 LOW ENERGY ION BOMBARDMENT INDUCED DAMAGE IN UO_2. Cavaleru, A. O. R.; Vasiliu, F. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 19: No. 3, 287-304 (1974).

The mechanisms of rare gases trapping in UO_2 are discussed in terms of the system of five stages originally proposed by Kelly and Brown. The low temperature gas release process has a major significance for low ion energies and fluences, whereas stages II and III become important for deeply located gas, dissolved in the lattice and in bubbles. The desorption spectra analysis following low energy ion bombardment in sintered and single crystal UO_2 is the basis for estimating the threshold energy for entrapment, the trapping coefficient, and its variation with both ion energy and implantation temperature and the activation energy for desorption. By comparing the desorption spectra from sintered and single crystal UO_2 the surface effects are clearly illustrated for sinters and practically they do not exist in single crystals. From the ion entrapment in UO_2 studies, information on gas dissolution, diffusion, and bubble formation processes could be derived. In annealing studies, recrystallization of near surface layers and changes of gas bubble distribution induced by energetic ion bombardment at high doses have been shown to be closely related to gas release stages. (auth)

13118 $M_{4,5}$ EMISSION SPECTRA FROM Gd_2O_3 AND Yb_2O_3. LaVilla, R.E. (National Bureau of Standards, Washington, D. C. 20234). Phys. Rev. A 9: No. 5, 1801-1805 (May 1974).

The $M_{4,5}$ emission spectra from Gd_2O_3 and Yb_2O_3 have been obtained in fluorescence on a double-crystal spectrometer. The profiles differ from the $M_{4,5}$ emission spectra excited by electron impact. These differences are due to resonance radiation and substantiate the interpretation given by Bonnelle and Karnatak. The $M\alpha$ emission line was found to lie above (in energy) the M_5-absorption resonance line in Yb_2O_3, which is in contrast to Gd_2O_3 and general experience. It is suggested that this observation is a result of the discrete nature of the absorption lines. With the help of estimated binding energies for the final configurations $5p^5{}_{1/2,3/2}4f^7$, the photoelectron spectrum of Gd_2O_3 is discussed. (auth)

13119 WORK FUNCTIONS OF BINARY COMPOUNDS. Yamamoto, S.; Susa, K.; Kawabe, U. (Central Research Laboratory, Hitachi Ltd., Kokubunji, Tokyo, Japan). J. Chem. Phys. 60: No. 10, 4076-4080 (15 May 1974).

A new semiempirical model for predicting the work function of binary compounds is proposed. The model is a modification of the Gordy and Thomas relation and is applicable to binary compounds. The work functions of binary compounds, ϕ_{AB} are found to be primarily determined by the properties of the element of low work function, A, perturbed by the other element of high work function, B, according to $\phi_{AB}=\phi_A+(1.41/d_A)[(2\phi_A-\phi_B-0.34)/(\phi_A+\phi_B-0.68)]$. Experimental values tabulated by Fomenko are compared with the predicted work functions, and the quantitative agreement is good in spite of the simplicity of the model. (auth)

13120 THERMAL CONDUCTIVITY OF VANADIUM AND CHROMIUM MONONITRIDES. Aivazov, M.I.; Muranevich, A.K.; Domashnev, I.A. (Institute of New Chemical Problems, Academy of Sciences of the USSR). High Temp. 11: No. 4, 690-692 (Mar 1974).

The coefficients of the thermal conductivity of vanadium and chromium mononitrides have been measured in the range 100–1100°K and compared with the relevant data for $TiN_{0.94}$. The increase in the thermal conductivity of $VN_{0.95}$ at high temperatures is assumed to be due to heat transfer by free carriers. The considerable difference between the true Lorentz number and the theoretical value $L_0=(\pi^2/3)(k/e)^2$ in $VN_{1.0}$ at extremely low carrier mobility is attributed to the inelastic scattering of electrons at the optical vibrations of the lattice. The increase in the ionicity of the metal-nitrogen bond in $CrN_{0.98}$ as compared with $TiN_{0.96}$ and $VN_{0.95}$ is accompanied by a substantial reduction of the thermal conductivity. Values of n_{el} and n_{ph} have been determined for $CrN_{0.98}$ from the Wiedemann–Franz relationship, the scattering parameter r being taken from the temperature dependence of the current-carrier mobility. (auth)

13121 THERMAL DIFFUSIVITY AND THERMAL CONDUCTIVITY OF TITANIUM AND ZIRCONIUM CARBIDES AT HIGH TEMPERATURES. Korshunov, I.G.; Zinov'ev, V.E.; Gel'd, P.V.; Chernyaev, V.S.; Borukhovich, A.S.; Shveikin, G.P. (S. M. Kirov Ural Polytechnic Institute). High Temp. 11: No. 4, 803-805 (Mar 1974).

An investigation has been made of the thermal diffusivity a of the stoichiometric carbides of titanium and zirconium in the temperature range 1300–2500°K, using the method of plane temperature waves at a frequency of 168.8 Hz. (AIP)

13122 EFFECT OF THERMAL CYCLING ON THE STRUCTURE AND PROPERTIES OF A Co, Cr, Ni–TaC DIRECTIONALLY SOLIDIFIED EUTECTIC ALLOY. Dunlevey, F. M.; Wallace, J. F. (Case Western Reserve Univ., Cleveland). Met. Trans.; 5: No. 6, 1351-1356(Jun 1974).

A Co, Cr, Ni matrix, TaC reinforced, directionally solidified eutectic alloy was tested under conditions of thermal fatigue. The material was cycled between 427 and 1093°C for up to 5000 cycles. The stress rupture properties are decreased by thermal cycling. This loss in stress rupture properties varies with the number of cycles; the initial loss in properties at about 200 cycles is relatively high. The stress rupture strength improves with further cycling up to 2000 cycles and decreases for a larger number of cycles. The TaC fibers in the cycled material developed surface serrations which increased with maximum cycling temperature and number of cycles. The formation of these serrations is attributed to the increasing solubility of the TaC fibers in the matrix with temperature. Since the easy growth planes of the TaC fibers were not coincident with the fiber faces exposed to the matrix, the TaC which was dissolved and reprecipitated during thermal cycling formed these serrations on the easy growth planes of the fibers. These serrations act as notches which reduce the tensile strength of the fibers. (auth)

13123 INFLUENCE OF COMPOSITION AND THERMO-MECHANICAL CONDITION ON MECHANICAL PROPERTIES OF TaC AND TaB STRENGTHENED CHROMIUM. Filippi, A. M. (Westinghouse Electric Corp., Pittsburgh). Met. Trans.; 5: No. 6, 1423-1427(Jun 1974).

Mechanical properties were related to composition and condition for chromium alloys strengthened with TaC, TaB, and TaC + TaB. A 0.25 to 1.00 mole percent alloying range was investigated. Thermomechanical condition had a similar influence on high temperature strength of the three alloy types. Tensile strengths were highest for heavily warm worked material. Maximum rupture strengths were obtained in the solution treated and aged condition. Composition and alloy content had major influences on rupture properties. Rupture strength was greatly improved by using the alloying phases together as opposed to individually, and a possible synergistic effect was measured. A strong direct relationship between alloy content and the stress dependency of rupture life was observed. Some improvement in low temperature ductility was obtained by heat treatment and an increase of alloy content, but the lowest ductile-to-brittle transition temperature measured was 300°F. Precipitation of the strengthening phases in chromium was also evaluated from electron microscopy and crystallographic data. A (100) habit was identified for the carbide and postulated for the boride. (auth)

13124 DISPERSOID GROWTH IN Ni–$2ThO_2$ DUE TO SELF-DIFFUSION SINTERING OF PARTICLE CLUSTERS. Kimmel, E. R. (Pennsylvania State Univ., University Park); Scheithauer, W. Jr. Met. Trans.; 5: No. 6, 1495-1500(Jun 1974).

The growth rates and activation energy for growth of thoria particles in thoria dispersion-strengthened nickel were measured after elevated temperature exposure. Growth was determined by direct measurement of thoria particle size on transmission electron micrographs. The thoria particles were distributed spatially in clusters in the hot consolidated alloy. Presence of particle clusters was found to provide the proper environment for a self-diffusion sintering-type particle coarsening. The rapid particle growth observed in this alloy form had too high a rate constant and too low an activation energy to constitute an Ostwald ripening mechanism, and was considered to reflect the grain growth stage of sintering. Further studies showed that thermomechanical treatments of hot consolidated material retarded this type of particle growth, by mechanically dispersing the ThO_2 particle clusters. (auth)

13125 COMMENT ON ac CONDUCTIVITY OF SCANDIUM OXIDE AND A NEW HOPPING MODEL FOR CONDUCTIVITY. Rockstad, H. K. (Energy Conversion Devices, Inc., Troy, MI); Pike, G. E. Phys. Rev., B; 8: No. 8, 4026-4027(15 Oct 1973).

In the paper by Pike [Phys. Rev. B6, 1572 (1972)] on ac conductivity, the relaxation time for classical (over-the-barrier) hopping is assumed proportional to $\phi(R/a)\exp(W/kT)$, where W is the barrier height and $\phi(R/a)$ is a function which depends on the site separation R. For the classical hopping mechanism the correct form of $\phi(R/a)$ varies weakly with R/a, but the paper may have inadvertently implied that $\phi(R/a)$ had the strong exponential dependence encountered in the quantum hopping or tunneling process. This comment is to clarify the situation by

discussing the processes which contribute to $\phi(R/a)$ in more detail. (auth)

13126 CORE TRANSITIONS FROM THE Al 2p LEVEL IN AMORPHOUS AND CRYSTALLINE Al_2O_3. Balzarotti, A. (Univ., Rome); Bianconi, A.; Burattini, E.; Grandolfo, M.; Habel, R.; Piacentini, M. Phys. Status Solidi (b); 63: No. 1, 77-87(1 May 1974).

The soft-x-ray spectra of aluminum oxide in the polycrystalline (γ) and amorphous forms have been investigated in detail with improved resolution using the synchrotron radiation of the Frascati electron synchrotron. In contrast to a previous measurement, it is found that the $L_{2,3}$ threshold starts at almost the same energy in both forms. The sharp peaks observed at the absorption edge are interpreted as excitons. This picture fits well both with electron spectroscopy results and with the optical spectra at the fundamental edge in the ultraviolet. It is suggested that metastable excitons are responsible for the intense structure observed at (82.6 ± 0.3) eV in the ordered phase and lacking in the amorphous phase. The spectral features of crystalline alumina are analyzed on the basis of the band structure. The modifications induced by the lack of long-range order in the amorphous samples are discussed. (auth)

13127 UNIAXIAL-STRESS-INDUCED SPLITTING OF PLASMA EDGE IN SINGLE CRYSTALS OF MB_6 COMPOUNDS. Iller, A. (Inst. of Physics, Warsaw). Phys. Status Solidi (b); 63: No. 1, 69-75(1 May 1974).

Uniaxial-stress-induced shift and deformation of the plasma edge has been observed in polarized light for single crystals of LaB_6, PrB_6, NdB_6, and CeB_6. Stress modulation techniques were used. It is shown that the shift and deformation of the plasma edge is due to the change of the parameters which determine the reflectivity in this region, i.e. free electron concentration, effective mass, relaxation time, and lattice dielectric constant. The change of the parameters was estimated and the shift of the plasma edge determined, using experimental results for all investigated compounds. (auth)

13128 LATTICE IMAGE OF $Nb_{12}O_{29}$ OBSERVED BY A 1000-kV ELECTRON MICROSCOPE. Horiuchi, S.; Muramatsu, K. (National Institute for Researches in Inorganic Materials, Sakura-mura, Niihari-gun, Ibaraki, 300-31 Japan); Uchida, Y. J. Appl. Phys. 45: No. 7, 3199-3200 (July 1974).

A two-dimensional lattice image, representing the array of niobium atoms in a $Nb_{12}O_{29}$ crystal, was observed by means of a high-resolution 1000-kV electron microscope. A large number of diffracted waves, being characteristic of the fast electron beam, were used in imaging. (auth)

Metals and Alloys

13129 (KFK-1942) MECHANICAL PROPERTIES OF CLADDING MATERIALS AFTER ANNEALING WITH CARBIDE FUELS. Goetzmann, O.; Hofmann, P.; Sarikaya, Y. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Material- und Festkoerperforschung). Oct 1973. 31p. (CONF-731065-2). Dep. NTIS (US Sales Only) $4.75.

From meeting on gas-cooled fast reactors; Wuerenlingen, Switzerland (23 Oct 1973).

Carburization of the cladding material (1.4988, 316, and 304 stainless steels; VTi3Si; and VTi2Cr15) is the only critical chemical interaction between fuel and cladding that is to be expected in a carbide pin and will greatly affect the mechanical properties of the cladding material. The mechanical properties of the steels (elongation and tensile strength) are most affected when annealed with carbide fuels at 600°C. At 500°C, carburization is still low. At higher temperatures (above 700°C), a resolution of carbide precipitates takes place. Fuel composition and bonding medium have a marked influence on the mechanical properties. Room-temperature elongation values for steel as well as for vanadium base alloy specimens annealed at 600°C are very low. With sodium bonding they drop to practically zero. However, elongation values at higher temperatures are still satisfying. Hardness measurements, mechanical properties, and carbon contents of the cladding materials after annealing can well be related. (20 fig) (auth)

13130 (RDT-M-3-35-T(5-74)) 2¼%-CHROMIUM, 1%-MOLYBDENUM ALLOY STEEL SEAMLESS TUBES (ASME SA-213 WITH ADDITIONAL REQUIREMENTS). (USAEC Division of Reactor Research and Development, Washington, D. C.). May 1974. 23p. RSO.

This standard covers seamless 2¼% Cr-1% Mo alloy steel tubes for use in heat exchangers and steam generators covered by the ASME boiler and pressure vessel code, Section III, for Class 1 components. Process, manufacture, heat treatment, surface condition, chemical composition, check analysis, tensile properties, mechanical tests, grain size determination, finish, and marking are specified. (DLC)

13131 (SLA-74-5322) HIGH PRESSURE DIFFERENTIAL THERMAL ANALYSIS EXPERIMENTS WITH THE $LaNi_5$-H SYSTEM. Wemple, R. P. (Sandia Labs., Albuquerque, N. Mex. (USA)). 1973. 15p. (CONF-740634-1). Dep. NTIS $4.00.

From third ARAZ symposium; Albuquerque, New Mexico, USA (5 Jun 1974).

Experiments have been performed on the $LaNi_5$-H system using a newly developed differential thermal analysis (DTA) device capable of 680 atm. Interpretation of the experimental results confirms that the DTA technique is a reliable qualitative method for determining phase boundaries, thermodynamic properties, transition temperature, and hydriding susceptibility of materials. General information on the kinetics of the hydriding reaction and effects of sample contamination can also be obtained. (8 figures) (auth)

13132 METALS. Hogendoorn, W. M. pp 3-171 of Handbook of Precision Engineering. Vol. 2. Davidson, A. (ed.). New York; McGraw-Hill Book Co. (1970).

The six sections of this chapter deal respectively with: properties of metals and their alloys, heat treatment of metals and tempering of steels, nonferrous metals, ferrous metals, spring materials, and bearing materials (including plastics). (100 figures, 71 tables, 74 references) (DLC)

13133 HEAT RESISTANT Ni-Al-Be ALLOYS. Komatsu, N.; Suzuki, T.; Ito, T. (to Kabushiki Kaisha Toyota Chuo Kenkyusho). US Patent 3,807,992. 30 Apr 1974. Priority date 27 Dec 1970, Japan. 12p.

A group of three kinds of improved heat resistant alloys containing Ni, Al, and Be as main constituents are described. The first kind further comprises 0.01-4% of at least one of the additional elements Mo, Cr, and Co, the second kind further comprising 0.01 to 1% of at least one of the additional elements Ti, Zr, V, Nb, W, Mn, and Cu, and the third kind further comprising 0.01 to 4% of at least one of the additional elements Mo, Cr, and Co and 0.01 to 1% of at least one of the additional elements Ti, Zr, V, Nb, W, Mn, and Cu. These improved heat-resistant alloys have excellent antioxidizing and high tensile properties at temperatures between 1,000 and 1,2000°C and are highly adapted for use in manufacturing machine parts subjected to high temperatures and severe loads. (auth)

13134 PERFORMANCE OF PLATINUM-CLAD TANTALUM ANODES IN ELECTROPLATING. Skomoroski, R. M.; Baboyan, R.; Zobbi, R. G.; Camp, E. K. Plating; 60: No. 11, 1115-1119 (Nov 1973).

The performance of Pt-clad Ta anodes in various electroplating baths has been evaluated. Until recently, the min thicknesses of Pt used on such anodes were 6.4 μm. However, various developments in metal technology were used to prepare Pt-clad Ta anodes containing only 3.2 μm of Pt. Comparative use tests with both types of Pt-clad Ta in Au, Rh, Ru, and Pd electroplating baths have shown that their performance is similar. (Metals Abstr.)

13135 ELECTROCHEMICAL REDUCTION OF OXYGEN ON NICKEL-LANTHANUM ALLOYS. Khrushcheva, E. I. Elektrokhimiya; 9: No. 7, 915-919(Jul 1973). (In Russian).

A study was made of the electrochemical reduction in 0.1 N KOH solutions of O on Ni and on Ni-La alloys containing 0.1 to 10 wt % La. The phase composition of the alloys was determined by x-ray analysis, that of the surface layers by electron diffraction, and the microstructure of the etched surface was examined by microscope. The activity of the Ni-La alloys was always higher than the activity of pure Ni, maximum activity being shown by alloys containing 1 to 5% La. Alloys prepared in a magnesite crucible contained Ni and Ni_5La, and had a lower activity than alloys prepared in a graphite crucible; the latter alloys contained La_2C_3. The presence of C in the alloy favored the formation of $La(OH)_3$. (Metals Abstr.)

Corrosion and Erosion

Refer also to abstracts 13305 and 14638.

13136 (GKSS-72-E-4) ISOTHERMAL HYDROGEN DIFFUSION IN ZIRCALOY-YTTRIUM COMBINATIONS. Frisius, F.; Lahann, H. J.; Mertins, H.; Spalthoff, W.; Wille, P. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Geesthacht-Tesperhude (F. R. Germany)). 1972. 11p. (AED-Conf-72-44-1).

From international meeting on hydrogen in metals; Juelich, Germany (20 Mar 1972).

Zirconium alloys are used increasingly in light-water-reactors as cladding for fuel elements. During operation hydrogen is picked up by zirconium, which, at higher concentration, precipitates as zirconium hydride, thereby limiting the useful life of the zirconium tubes through embrittlement. In order to prevent the hydrogen embrittlement, yttrium can be inserted as a hydrogen-getter inside the fuel can in a suitable manner. For a better understanding of this process the hydrogen diffusion in a combination of two metals with different affinities to hydrogen is investigated experimentally and theoretically under simplified conditions as slab-diffusion, constant temperature, and solid solution of hydrogen in the α-phase of zirconium and yttrium alone. (GE)

13137 (KFK-1903) SELF-WELDING OF STRUCTURAL MATERIALS IN LIQUID SODIUM. Huber, F.; Mattes, K.; Weinhold, H. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Reaktorentwicklung). Feb 1974. 82p. (In German). Dep. NTIS (US Sales Only) $7.25.

Self-welding in liquid sodium under specific conditions of components of sodium-cooled reactors must be taken into account with respect to its effects upon operational safety. Four materials were investigated: 1.4301 stainless steel, 1.4981 stainless steel, 1.6770 steel, and Inconel 718. The influence of the respective parameter was determined by variation of the temperature, time, contact pressure, and surface finish. From the results, self-welding can be subdivided into three single processes: reduction of the material surface by sodium, deformation of the points of contact and formation of a supporting area as a result of the contact pressure, and self-welding of the supporting area by recrystallization. An attempt is made to develop an empirical relation allowing one to estimate the forces required for the separation of self-welded components and to select the most suitable material with respect to self-welding behavior. (18 fig) (auth)

13138 (N-74-15660) EVALUATION OF COATED NIOBIUM ALLOY HEAT SHIELDS FOR SPACE SHUTTLE THERMAL PROTECTION SYSTEM APPLICATION. Volume 2, Phase 2. Subsize Heat Shield and Small Size TPS Evaluation. Report For February 1971–July 1973. Black, W. E. (General Dynamics/Convair, San Diego, Calif. (USA)). Aug 1973. Contract NAS1-9793. 540p. (NASA-CR-112119-2). NTIS $29.00.

Initially a trade study was conducted of seven heat shield configurations. These were evaluated for structural reliability, fabricability, weight, inspectability, and refurbishability. Two concepts, a tee-stiffened and an open corrugation, were selected as offering the most potential for system success. Fourteen subsize heat shields of a full scale section were fabricated from C-129Y and Cb-752 and silicide coated with R-512E. These subsize panels were subjected to a simulated flight profile representing temperature, local surface pressures, and applied pressure differential loads. All corrugated panels of both alloys sustained 100 cycles without structural or coating failure. All Cb-752/R-512E panels performed well with one panel being successfully repaired after 66 cycles and completing 100 cycles. As a result of this evaluating the Cb-752/R-512E system was selected for hardware application during the subsequent phases. In addition, the tee-stiffened configuration was selected for further development and application in Phase III. This selection was based on an overall assessment of relative weight, cost, and structural performance of the tee-stiffened and open corrugation TPS. (STAR)

13139 AES MEASUREMENTS OF ADSORPTION ISOBARS FOR OXYGEN ON TUNGSTEN AT LOW PRESSURE AND HIGH TEMPERATURE. Dabiri, A. E.; Aramati, V. S.; Stickney, R. E. (Massachusetts Inst. of Tech., Cambridge). Surface Sci.; 40: No. 2, 205-215(Nov 1973).

Auger electron spectroscopy (AES) has been employed to determine the relative coverage of oxygen on polycrystalline tungsten at high temperatures ($1200 \leq T \leq 2500$°K) and low O_2 pressures ($5 \times 10^{-9} \leq p_{O_2} \leq 5 \times 10^{-6}$ torr). It is believed that this is the first demonstration that chemical analysis of solid surfaces by AES is possible even at temperatures as high as 2500°K. It is assumed that the relative oxygen coverage is directly proportional to the peak-to-peak amplitude of the first derivative of the 509 eV oxygen Auger peak. The experimental results illustrate the dependence of coverage on temperature and pressure, and it is shown that the results for low coverages may be described reasonably well by a simple first-order desorption model plus a semi-empirical expression for the equilibration probability (or sticking coefficient). On the basis of this approximate model, the binding energy of oxygen on tungsten is estimated as a function of coverage, giving a value of ~140 kcal/mole in the limit of zero coverage. (auth)

13140 SEQUENTIAL ADSORPTION OF DEUTERIUM AND ETHYLENE ON POLYCRYSTALLINE AND SINGLE CRYSTAL PLANES OF TUNGSTEN. Cartier, P. G. Ithaca, NY; Cornell University (1973). 126p. University Microfilms Order No. 74-6381.

Thesis (Ph. D.).

The adsorption was studied on polycrystalline and the (110), (100), (112), and (111) surfaces of W using thermal desorption mass spectroscopy. The sequence of adsorption was found to be critical. D_2 will not adsorb on a C_2H_4-covered W surface; however, when a D_2-covered surface was exposed to an ethylene dose just sufficient to saturate a bare surface, varying amounts of C_2H_4 will adsorb. The major gaseous products observed in thermal desorption are H_2, HD, and D_2; however, small amounts of ethane were also detected. On polycrystalline W, 0.41 of a monolayer of C_2H_4 adsorbs with loss of 0.14 monolayer of D_2. Both the coverages of D_2 and C_2H_4 and the general shape of the desorption on polycrystalline W were found to be describable in terms of reasonable contributions from the four low index planes. On both the (110) and (112) planes such adsorption leads to 0.24 and 0.37 monolayers of C_2H_4, respectively, with no displacement of D_2. Since the resulting spectra are apparently superpositions of C_2H_4 and D_2 spectra, it appears that C_2H_4 and D_2 in part occupy separate sites. Specifically, on W(112) the β_2-hydrogen and C_2H_4 sites were shown to be independent. On both the (100) and (111) planes, adsorption of C_2H_4 occurs through displacement of 1.3 molecules of D_2 per C_2H_4 adsorbed. This displacement is more extensive on the (111) plane: $\theta_{C_2H_4} = 0.86$ and $\theta_{D_2} = 0.36$ on W(111) vs $\theta_{C_2H_4} = 0.52$ and $\theta_{D_2} = 0.67$ on W(100). Displacement on W(100) occurs through adsorption of C_2H_4 on sites separate from D_2 with the C_2H_4 perturbing the D_2 sufficiently to lead to desorption. On W(111) hydrogen displacement is a thermal process occurring through the low temperature states with both D_2 displaced by C_2H_4 and H_2 by D_2. The fraction of C_2H_4 converted to ethane varies from surface to surface, but never more than 1.5% of the chemisorbed C_2H_4. The order of activity of the single-crystal planes for both hydrogenation and deuteration is consistent with the Horiuti–Polanyi mechanism $H^* + {}^*CH_2 - {}^*CH_2 \rightleftharpoons {}^*CH_2 - CH_3 + 2^*$ (1) and ${}^*CH_2 - CH_3 + {}^*H \rightarrow CH_3 - CH_3(g) + 2^*$ (2). The crystallographic dependence for hydrogenation and deuteration is a consequence of the reverse of Eq. 1 with the probability for occurrence of this reverse step decreasing with increasing metal-metal spacing. A high density of short spacing as exists on W(110) would yield the observed small amounts of ethane along with extensive incorporation of D atoms, while the high density of long spacings existing on W(111) would yield the observed larger amounts of ethane with less extensive incorporation of D atoms. (Diss. Abstr. Int., B)

13141 PREPARATION AND THE SURFACE OXIDATION OF THE (110) FACE OF VANADIUM. Al Khoury Nemeh, E.; Cinti, R. C. (CNRS, Grenoble, France). Surface Sci.; 40: No. 3, 583-594(Dec 1973). (In French).

A method for obtaining a (110) plane of acceptable purity is described. This surface is characterized by LEED and Auger spectroscopy; effects of annealing and ion-bombardment are given, and the major importance of sulfur diffusion in the crystal cleaning process is demonstrated. The interactions between the surface and oxygen are also studied, in the low pressure range, by LEED and work function measurements. No ordered surface structures are found; these observations show that oxygen dissolves in vanadium even at low temperature. (auth)

13142 GENERAL MODEL FOR THE INTERACTION OF LOW PRESSURE OXYGEN WITH TRANSITION METALS AT HIGH TEMPERATURE. Weber, B.; Cassuto, A. (CNRS, Villers, France). Surface Sci.; 39: No. 1, 83-99(Aug 1973). (In French).

A general model is presented for the interaction of low pressure oxygen with transition metals at high temperatures, when all products are volatile. It is based on the following major hypotheses: (a) adsorption of molecular oxygen is the only direct process between the gas phase and the surface; (b) all chemical reactions occur in the adsorbed layer. This model is in agreement not only with experimental results on platinum and rhenium but also with those on different metals (W, Mo, Ta, and Nb). It becomes identical to Stickney's quasi-equilibrium theory when assuming that desorption activated complexes are identical to molecules moving freely in a plane parallel to the surface. (auth)

13143 CORROSION OF LIQUID ALLOYS OF ZINC WITH YTTRIUM AND WITH RARE-EARTH ELEMENTS IN LiCl–KCl MELTS. Kovalevskii, A. V.; Lebedev, V. A.; Nichkov, I. F.; Raspopin, S. P. (Ural Polytechnic Inst., Sverdlovsk, USSR). J. Appl. Chem. USSR (Engl. Transl.); 46: No. 11, 2743-2745 (Nov 1973).

Translated from Zh. Prikl. Khim.; 46: No. 11, 2590-2593(Nov 1973).

Alloys of Zn with Ce, Nd, La, Dy, Er, Y, Sm, or Yb were prepared; the metal content in the Zn was 8 to 10 wt%. The cor-

rosion and stationary potential in LiCl–KCl melt was measured at 500 to 700°C. The temperature dependence of the stationary potential is linear. (DLC)

13144 APPLICATIONS OF THERMODYNAMICS FOR PREDICTING AND UNDERSTANDING THE PERFORMANCE OF FAST BREEDER REACTOR OXIDE FUELS. Leitnaker, J. M. (Oak Ridge National Lab., TN). J. Nucl. Mater.; 51: No. 1, 95-105 (May 1974).

Intergranular corrosion of stainless steel cladding during fast reactor operation appears to be a limiting factor in design of fuel pins. Presently available data can be treated by a simple rate equation with reasonable agreement and the implication is that the rate limiting mechanism is the same in all cases studied. Since some fuel pins perform better than others, the possibility exists that intergranular corrosion can be greatly reduced, thereby increasing the fuel pins' reactor life. Data needed to complete the understanding of this corrosion are described. (auth)

13145 ELECTROCHEMICAL REDUCTION OF OXYGEN ON THERMALLY OXIDIZED NICKEL–LANTHANUM ALLOYS. Krushcheva, E. I. Elektrokhimiya; 9: No. 7, 1028-1031(Jul 1973). (In Russian).

A study was made of O reduction on a thermally oxidized Ni–La alloy containing La 1 and C 0.4%, and pure Ni. From an electron-microscope examination of specimens oxidized at 400°C, it was seen that the structure of the oxide layer on pure Ni differed from that on the alloy; the oxide layer on Ni consisted of larger crystals (500-800 Å) than on the alloy. In the alloy the primary Ni crystals of dia 40-60 μm were surrounded by a film, 3-5 μm thick, of finely dispersed eutectic mixture consisting of Ni and Ni_5La, the structure and size of which determined the character of the nucleation, structure and size of the Ni oxide crystals formed on the alloy. (Metals Abstr.)

13146 STUDY OF IRON, ZIRCONIUM, TITANIUM, NIOBIUM ANODIC OXIDATION BY THE IMPEDANCE METHOD. Ovcharenko, V. I.; Le, V. B. (Moscow Physical-Chemistry Inst.). Elektrokhimiya; 9: No. 11, 1618-1623(Nov 1973). (In Russian).

By measuring the impedance, the growth and properties of thin oxide layers on the rectifying elements Zr, Ti, Nb, and Fe were studied directly during potentiostatic and potentiodynamic anodic oxidation. It was shown that in all these metals, including Fe, poorly conducting layers are formed in the passive region of the potentials. The growth of these layers and their properties in alternating current obeyed identical laws. (tr-auth)

13147 EFFECT OF TANTALUM ON THE CORROSION RESISTANCE AND ELECTROCHEMICAL AND MECHANICAL PROPERTIES OF VANADIUM. Andreeva, V. V.; Stepanova, T. P.; Druzhinina, I. P.; Vladimirskaya, T. M. (Inst. of Physical Chemistry, Moscow). Prot. Metals (USSR) (Engl. Transl.); 9: No. 2, 166-168(1973).

Translated from Zashch. Metal.; 9: No. 2, 181-185(1973).

The Ta content was varied from 3 to 71.6 at.%, and the corrosion resistance was tested at 100°C in HCl, H_2SO_4, H_3PO_4, and HNO_3. The amount of Ta necessary to produce corrosion resistance may be determined from the figures. Potentiokinetic and anodic polarization curves were measured in 50% H_3PO_4 and 40% H_2SO_4. Hardness, resistivity, and density were also measured. (DLC)

13148 CORROSION CRACKING OF MARAGING STEEL. Lang, C.; Teindl, J. I. (Mining-Metallurgical Inst., Ostrava, Czech.). Prot. Metals (USSR) (Engl. Transl.); 9: No. 2, 139-142(1973).

Translated from Zashch. Metal.; 9: No. 2, 151-155(1973).

Results are presented of a study of corrosion cracking of semicommercial heats of maraging steel with 18% Ni in 3.5% NaCl in relation to austenitizing temperature. (auth)

13149 ACCELERATED TESTING OF ZINC AND CADMIUM FOR ATMOSPHERIC CORROSION IN CLIMATIC CHAMBERS. Mikhailovskii, Yu. N.; Shuvakhina, L. A.; Chin T'chi Hong Wang. (Inst. of Physical Chemistry, Moscow). Prot. Metals (USSR) (Engl. Transl.); 9: No. 2, 135-138(1973).

Translated from Zashch. Metal.; 9: No. 2, 147-150(1973).

A method is described for determining corrosion constants by testing the metals in artificial-climate chambers; results of a forecast of the corrosion of zinc and cadmium in various climatic regions are presented. (auth)

13150 INVESTIGATION OF THE PECULIARITIES OF THE OXIDATION OF ZIRCONIUM (IN THE GAS PHASE) IN THE TEMPERATURE INTERVAL 1000 TO 1400°C ACCORDING TO ELECTROCHEMICAL PARAMETERS. Opara, B. K.; Vtulkin, A. V.; Fokin, M. N.; Kravetskii, G. A.; Rakoch, A. G. (Moscow Inst. of Steel and Alloys). Prot. Metals (USSR) (Engl. Transl.); 9: No. 2, 121-125(1973).

Translated from Zashch. Metal.; 9: No. 2, 131-136(1973).

The dependence of the emf arising in the oxide film on zirconium and of the current passing through it on the temperature and partial pressure of oxygen in the gas phase was studied, using $Zr|ZrO_2|Pt, O_2$ cells. An effect was observed due to the structural transformation of ZrO_2. (auth)

13151 OBSERVATION OF OXIDE PARTICLES BELOW THE APPARENT OXYGEN SOLUBILITY LIMIT IN TANTALUM. Stecura, S. (Lewis Research Center, Cleveland). Met. Trans.; 5: No. 6, 1337-1340(Jun 1974).

The apparent solubility of oxygen in polycrystalline tantalum as determined by the x-ray diffraction lattice parameter technique is about 1.63 at. % at 820°C. However, oxide particles were identified in samples containing as low as 0.5 at. % oxygen. These particles were present at the grain boundaries and within the grains. The number of oxide particles increased with increasing oxygen concentration in tantalum. The presence of oxide particles suggests that the true solubility in the polycrystalline tantalum metal is probably lower than that reported in the literature. (auth)

13152 ELLIPSOMETRIC STUDY OF THE TEMPERATURE DEPENDENCE OF THE ANODIC OXIDATION OF TANTALUM. Neergaard, J. R. Birmingham, AL; Univ. of Alabama (1973). 75p. University Microfilms Order No. 74-9375.

Thesis (Ph. D.).

The anodic oxidation of tantalum in 1N sulfuric acid was studied as a function of the temperature at which the oxidation occurs. Open-circuit electrical transients were recorded and analyzed to determine the values of the parameters i_0 and V_0 in the relation $i = i_0 \exp(V/V_0)$. Simultaneously, the growth of the anodic layer was monitored in situ using an automatic nulling ellipsometer. A comparison of the behavior of the parameter V_0 and that of the thickness of the oxide layer as functions of temperature leads to a verification of the relation $V_0 = (kT/qa)$ D, within the error of the experiments performed. The behavior of i_0, V_0, the layer thickness, and the electric field in the layer as functions of temperature is discussed. (Diss. Abstr. Int., B)

13153 ALUMINUM CORROSION STUDIES. I. Potential-pH-Temperature Diagrams for Aluminum. Lowson, R. T. (Australian Atomic Energy Commission, Sutherland). Aust. J. Chem.; 27: No. 1, 105-127(Jan 1974).

The potential–pH– temperature relationships for the aluminum–water system were calculated by the methods of de Bethune, Khodakovskiy, Criss and Cobble, and Helgeson and a critical comparison made. The Criss and Cobble method produced the most consistent results and was used to construct a corrosion diagram for the range 25-300°C. The effect of the hydrolysed ions $Al(OH)^{2+}$, $Al(OH)_2^+$, and $Al(OH)_3^0$ was also calculated. A temperature effect was found which should be taken into account when designing and operating aluminum circuits in which different parts are operated at different temperatures. (auth)

Preparation and Fabrication

13154 (COO-3158-31) COMPUTERIZED CONTROL AND DATA ACQUISITION SYSTEM FOR QUENCHING AND ANNEALING THIN METAL WIRES. Report No. 2183. Huang, H. C. W.; Berger, A. S. (Cornell Univ., Ithaca, N. Y. (USA). Dept. of Materials Science and Engineering). 1973. Contract AT(11-1)-3158. 17p. Dep. NTIS $4.00.

In the study of the thermal generation and the annealing of point defects, e.g., vacancies, in metal crystals, it is necessary to have accurate and reproducible control over the thermal history of the specimen. This paper describes a computer-controlled system for the rapid thermally pulsing, quenching, and annealing (thermal cycling) of thin metal wires. The system features complete software control of the temperature vs time profile of the sample. Using programmable gain instrumentation amplifiers and a crystal-controlled programmable time base, both rapid and accurate ($dT/dt \leq 10^6$ °K/sec; $\Delta T \leq \pm 5$°K) control of the thermal cycle is obtained. (auth)

13155 INTERACTION OF COBALT WITH NIOBIUM ON EXPLOSIVE WELDING AND FOLLOWING ANNEALINGS. Dunaev, S. F.; Kuprina, V. V.; Slyusarenko, E. M.; Kuznetsova, S. M. Vestn. Mosk. Univ., Ser. II. Khim.; 15: No. 1, 86-88(1974). (In Russian).

The reaction of cobalt with niobium on explosive welding and in the process of the following annealings was studied by metallographic and microroentgen-ray spectral analyses. (auth)

13156 SOLDERING ZIRCALOY PIPES FOR NUCLEAR CANS. Cabral Padilla, J. F. Mexico City; Instituto Politecnico Nacional (1973). 73p. (In Spanish).

Thesis.

The optimum conditions for soldering caps on fuel cans for power reactors were determined experimentally. A soldering installation using a W electrode and inert gas atmosphere was developed, and the conditions for obtaining a good solder and the variables affecting it were determined. The variables studied were electrode, arc length, protector gas, vacuum, soldering rate, amperage and voltage, and cleanliness of the surfaces. (JSR)

13157 ELECTRODEPOSITION OF INDIUM FROM AN ELECTROLYTE BASED ON TRILON B. Shluger, M. A.; Chmykhalo, E. G. (Moscow Evening Metallurgical Inst.). Prot. Metals (USSR) (Engl. Transl.); 9: No. 2, 211-213(1973).

Translated from Zashch. Metal.; 9: No. 2, 223-225(1973).

Anhydrous indium sulfate was used with Trilon B as ligand; ammonium sulfate was added as buffer. Good-quality In coatings could be deposited from the Trilon electrolyte at fairly high cathodic current densities (1 to 10 A/dm^2). Ammonium sulfate has a beneficial effect on the deposition. The electrolyte is composed of: 34 g/l indium sulfate, 80 g/l Trilon B, 100 g/l ammonium sulfate. At a current density of 1 to 5 A/dm^2, the deposition rate is 20 to 35 μ/h with a current efficiency of 65 to 70%. (DLC)

13158 PRODUCTION OF PURE ZIRCONIUM BY USE OF A RADIO FREQUENCY PLASMA. Gragg, F. M. Tucson, AZ; Univ. of Arizona (1973). 99p. University Microfilms Order No. 74-11,468.

Thesis (Ph. D.).

$ZrCl_4$ was reduced to Zr in a reactor powered by a 25 kW 4 MHz generator. The plasma was contained in a water-cooled Vycor tube. The argon carrier was dried by a mole sieve bed before entering either the plasma reactor or the feed system. Reagent grade $ZrCl_4$ was fed by means of a sublimation feed system, which not only further purified the $ZrCl_4$ but also fed the $ZrCl_4$ as a gas, which has transfer advantages. The product was collected on a water-cooled cold finger probe, which enabled the Zr to be quenched in the hottest part of the plasma. After the Zr was collected, care was taken not to expose the Zr to the atmosphere. The product was positively identified by x-ray diffraction; a wet analysis was run to determine the percent conversion. The feed rates were varied from 0.4404 to 4.658 g/h. The probe height was varied in order to collect product at different points in the plasma ball. The generator power was kept at 5.8×10^3 kcal/h. The percent conversions varied from 3.67 to 89.61%, increasing with decreasing feed rate and when the product was collected in the hotter portion of the plasma ball. From the energy balance, 36% of the power input to the generator was lost to the generator cooling water, another 40% lost to the reactor cooling jacket, and 4% lost to radiation, leaving 20% for the plasma itself. It was concluded that the production of Zr from $ZrCl_4$ is technically feasible, but that economical production is still in doubt. (DLC)

13159 GASLESS COMBUSTION OF A MIXTURE OF METALS AND SELF-PROPAGATING HIGH-TEMPERATURE SYNTHESIS OF INTERMETALLIDES. Naiborodenko, Yu. S.; Itin, V. I.; Merzhanov, A. G.; Borovinskaya, I. P.; Ushakov, V. P.; Maslov, V. P. (Tomsk State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 6, 145-146(1973). (In Russian).

The gasless combustion of mixtures of Ni and Al powders and of Al powder with Ni, Zr, Ti, Cr, Co, No, and W and the subsequent formation of intermetallides was studied. The effects of the porosity of the sample, the dispersion of Ni, and the dimensions of the Al particles in Al-Ni systems were studied. X-ray structure analysis of the Al-Ni system after combustion showed that a one-phase product, corresponding to the composition of the NiAl phase, is formed. In combustion of Al with the other metals it was found that combustion occurs only after preliminary heating but the characteristics of the combustion are the same as in the Ni-Al system. In the majority of cases, multiphase alloys were formed but one-phase alloys were formed in some systems. (JSR)

13160 WIREDRAWING DIES. II. Tungsten Carbide Wiredrawing Dies. Holroyd, A. Wire Ind.; 40: No. 479, 877-878(Nov 1973).

The correct grade of carbide must be selected for each application. The hardness is controlled by adjusting the Co content and can vary from 1050-1225 VPN, with 15% Co, to as much as 1700-1825 with 4% Co. Harder grades are necessary for drawing nonferrous wires. The steel bar drawer requires a grade that is both tougher and softer for this severe reduction. Choice of the correct die profile is considered, and the final polishing to precise die dimensions is described. Faults causing premature die failure are itemized. (Metals Abstr.)

Properties, Structure, and Phase Studies

Refer also to abstracts 12534, 13267, 13268, 14294, and 14537.

13161 (AD-771039) MAGNESIUM-YTTRIUM ALLOYS, SCALE-UP AND EVALUATION. Final Report. Peters, B. C.; Couling, S. L. (Dow Chemical Co., Midland, Mich. (USA)). Apr 1973. Contract DAAG11-69-C-0626. 97p. NTIS $3.75.

A magnesium alloy containing 9% yttrium, 1% zinc, and 0.5% zirconium was produced in the form of sheet and extrusions on production equipment and the resulting materials were then evaluated for structural performance. The measured room temperature strength properties of the sheet and extrusions were very high for a magnesium alloy. It was demonstrated that the sheet and extrusions can be fabricated into structural shapes and assemblies without undue difficulty. The projection was confirmed at a 21% weight reduction for a helicopter tail cone by switching certain components from aluminum to magnesium. The magnesium-yttrium panels, however, when tested to fracture, demonstrated little warning of impending rupture and it was concluded that this material was not acceptable for use in primary aircraft structures. (GRA)

13162 (AD-771502) STRUCTURAL FATIGUE. Final Report, September 15, 1968-September 15, 1973. McEvily, A. J. Jr. (Connecticut Univ., Storrs (USA)). Sep 1973. Contract F44620-69-C-0011. 17p. (AFOSR-TR-73-2202). NTIS $2.75.

Research programs involved alloy preparation, studies of environmental effects, elevated and room temperature fatigue behavior, creep-fatigue interaction studies, fatigue crack growth in stiffened and unstiffened panels, determination of threshold levels for fatigue crack growth, and an assessment of the role of fracture toughness and mean stress in fatigue crack growth. The fatigue behavior of composite materials as well as of a number of structural materials such as Ti-6Al-4V was investigated. Advances in the use of thermal conductivity to study dislocation arrays have been made, and the use of surface waves to detect and monitor fatigue cracks has been developed. (GRA)

13163 (AD-772103) CORRELATION OF MICROSTRUCTURES WITH FRACTURE TOUGHNESS PROPERTIES IN METALS. Final Report, June 1, 1972-September 30, 1973. Crossley, F. A.; Lewis, R. E. (Lockheed Missiles and Space Co., Palo Alto, Calif. (USA). Lockheed Palo Alto Research Lab.). 30 Sep 1973. Contract N00019-72-C-0545. 130p. (LMSC-D-356114). NTIS $4.50.

Ti-6Al-4V alloy was studied in three mill product forms for the purpose of establishing a correlation between microstructure and fracture toughness. Tension test, fracture toughness, and crack growth rate properties were determined. Light microscopy, scanning electron microfractography, and transmission electron microscopy were the metallographic means employed. A key factor in the microstructural and fracture toughness differences is cooling rate. The fatigue crack propagation rate was found to vary widely among the different microstructures. There was some correlation between microfractographic modes and fracture toughness. (GRA)

13164 (AGARD-R-618) SURVEY OF ACTIVITIES IN THE FIELD OF LOW-CYCLE HIGH TEMPERATURE FATIGUE. Critical Report. Drapier, J. M. (Advisory Group for Aerospace Research and Development, 92- Neuilly-sur-Seine (France)). Feb 1974. 148p. (CONF-731070-1). Dep. NTIS (US Sales Only) $10.50.

From 37th meeting of the AGARD structures and materials panel; The Hague, Netherlands (7 Oct 1973).

Following the 34th Meeting of the Structures and Materials Panel (April 1972), information on the activities in low cycle fatigue testing at high temperature (LCHTF) was gathered during the visit of 38 laboratories (industry and universities) from 7 NATO countries. Several facets of the LCHTF problem are covered: materials, testing equipment and conditions, types of data plots, latest developments in prediction laws for the fatigue behavior of materials, and design procedures for predicting lives in different engine components. The available information is given in this document. An attempt is also made to describe the reasons for the interest in the LCHTF problem and what seems to be the most important aspects to be investigated in future studies. (88 references, 142 figures) (DLC)

13165 (CEA-R-4567) STUDY OF PHASE TRANSFORMATIONS IN TITANIUM ALLOY. III. Study of Isothermal Transformations of Beta III Titanium Alloy. Vial, F.; Beauvais, C.; Fidelle, J. P.; Hocheid, B. (CEA Centre d'Etudes de Bruyeres-le-Chatel, 92 - Montrouge (France)). May 1974. 45p. (In French). Dep. NTIS (US Sales Only) $5.25.

The study of isothermal breakdown of Beta III Titanium Alloy (11.2% Mo-6.3% Zr-4.7% Sn) has allowed the drawing of TTT curves, after preheating at 850°C for 15 min. At this temperature, the alloy is made of two phases: β_0 (bcc) and δ (hcp). β_0 breakdown induces precipitation of α phase (H) above 450°C and of very fine ω phase particles below this temperature. Then during very long isothermal holdings, ω phase transforms to α. (auth)

13166 (COO-3429-23) MAGNETIC PROPERTIES OF $R_{2-x}R'_xCo_{17}$ COMPOUNDS (R = Gd, Dy, Ho OR Er, R' = Th OR Ce). Narasimhan, K. S. V. L.; Wallace, W. E. (Pittsburgh Univ., Pa. (USA). Dept. of Chemistry). 1973. 14p. Dep. NTIS $4.00.

Magnetic and structural characteristics of the tenary systems are presented. Incorporation of Th in the lattice stabilizes the Th_2Zn_{17} structure whereas incorporation of Ce does not; if the binary system has the Th_2Ni_{17} structure, the incorporation of Ce leaves the structure unchanged. The antiferromagnetic Ln–Co coupling observed in the Ln_2Co_{17} systems persists in the ternary alloys. The moment of the cobalt sublattice is decreased when more than half of the Ln is replaced by Th, suggesting that the extra electron contributed by Th enters the Co d-band or d-shell. The direction of easy magnetization is in the basal plane for all composition in the Gd, Dy, and Ho systems. In $Er_{2-x}Th_xCo_{17}$ the easy direction is along the c-axis for x = 0 and .2 but is in the basal plane for higher thorium contents. (auth)

13167 (HEDL-TME-74-11) MECHANICAL PROPERTIES OF ANNEALED AND COLD WORKED TYPE 316 STAINLESS STEEL FAST REACTOR SEAMLESS TUBING. Paxton, M. M. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Feb 1974. Contract AT(45-1)-2170. 57p. AT.

The mechanical properties of 20% cold worked AISI Type 316 Stainless steel tubing (0.230 in. OD × 0.20 in. ID) were determined. The short time uniaxial tensile, biaxial burst, and long-term biaxial stress rupture properties were evaluated on eight lots of prototypic FTR fuel cladding. All test data were reduced to provide graphical representation of the relationships between mechanical properties and test temperature or time and to provide an estimate of data confidence. These data are intended for use in design, performance prediction, and safety analysis of reactor components fabricated from 20% cold-worked Type 316 stainless steel. Test data in tabular and graphical form on eight additional tubing lots ranging from 0 to 30% cold work are also included. (22 fig, 20 tables) (auth)

13168 (INIS-mf-1300) EFFECTIVE AND MAGNETIC INTERACTIONS BETWEEN ELECTRONS IN MIXED CONFIGURATIONS OF TRANSITION ELEMENTS. Schrijver, J. (Amsterdam Univ. (Netherlands). Zeeman Lab.). 21 Jun 1972. 128p. (In Dutch). INIS.

A systematic analysis is made of the second-order effective (electrostatic and spin-orbit) and the magnetic (spin-spin, spin-orbit-orbit, orbit-orbit) interactions in mixed configurations $(d + s)^N$. The influence of these interactions on calculated energy levels is thoroughly investigated in six experimentally well known spectra of transition elements (Ti I, V II, Fe I, Nb II, Ru I, Os I). It is shown that three effective two-particle operators and eight three-particle operators are required to account for all electrostatic second-order perturbations. Introduction of the corresponding effective parameters leads to a strong reduction of the mean error in the calculated energy levels, while using a single value for each Slater parameter throughout the three configurations considered, just as required by the underlying central field model. The effect of three of the three-particle operators can alternatively be described by admitting independent Slater parameters for each configuration. Trees' relations between these parameters are shown to be obeyed exactly. The empirical values for the interaction parameters are compared with results of calculations using Klapisch' parametric potential method. The influence of spin-orbit induced effective operators and remaining magnetic interactions is examined. In Os I the introduction of this effective interaction leads to an important reduction of the mean error; in other spectra considered (Nb II, Ru I, Fe I) their effect is non-negligible. The main contributions to the spin-dependent effective parameters were calculated for Nb II. The contributions of orbit-orbit interaction to α and β and of spin-spin contact term to the Slater parameter were evaluated. (auth)

13169 (JINR-P3-7800) MEASUREMENT OF THE SLOW-NEUTRON SCATTERING AMPLITUDES FOR PRASEODYMIUM NUCLEI. Akopyan, G. G.; Alfimenkov, V. P.; Sharapov, E. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1974. 14p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

The neutron coherent-scattering amplitude for praseodymium was measured by the time-of-flight powder diffraction method with the dioxide PrO_2 as a sample. The value obtained is $(0.490 \pm 0.015) \times 10^{-12}$ cm. The total neutron scattering cross section for Pr metal, $\sigma_s = 3.1 \pm 0.2$ b, was measured for neutron energies from 0.5 to 10.0 eV. The upper limit to the spin-incoherent cross section was established: $\sigma_{inc} \leq 0.4$ b. (4 figures, 1 table) (auth)

13170 (KFTI-73-6) PLASTIC DEFORMATION OF POLYCRYSTALLINE BERYLLIUM. Ivanov, V. E.; Khristenko, I. N.; Papirov, I. I.; Tikhinskii, G. F.; Volokita, G. I.; Shokurov, V. S. (AN Ukrainskoj SSR, Kharkov. Fiziko-Tekhnicheskij Inst.). 1973. 98p. (In Russian). INIS.

The temperature and rate dependence of the strength of cast and metalloceramic Be with different grain sizes were studied. The values of the activation energy and the activation volume and their dependence on the type of metal and the deformation conditions were determined. A series of abnormal effect of plastic deformation were observed. Conclusions were made on the atomic mechanism and the characteristics of the movement of the dislocations in the Be. Results were compared with data for monocrystalline Be and with the results of studies on other metals with hcp structure. (tr-auth)

13171 (N-73-32426) CORRELATION OF CREEP RATE WITH MICROSTRUCTURAL CHANGES DURING HIGH TEMPERATURE CREEP. Annual Report, 1 July 1972–30 June 1973. Young, C. T.; Hochella, W. A.; Lytton, J. L. (Virginia Polytechnic Inst. and State Univ., Blacksburg (USA). Div. of Minerals Engineering). Sep 1973. 37p. (NASA-CR-135698). NTIS $4.00.

The techniques of electron microscopy were used to examine the microstructural changes which occur during primary creep for two important types of engineering alloys: (1) alloys strengthened by solid-solution additions, and (2) dispersion-strengthened alloys. The metals chosen for study are unalloyed titanium, Ti-6Al-4V, and the cobalt-base alloy, Haynes 188. Results show that development of prior dislocation substructure in Haynes 188 by 10% prestrain and annealing for one hour at 1800°F increases the time to reach 0.5% creep strain at 1600°F by more than an order of magnitude for creep stresses from 3 to 20 ksi. For creep at 1800°F, similar results were obtained for stresses above 7 ksi, but the prior substructure decreases creep resistance below 7 ksi. This effect appears to be related to instability of grain structure at 1800°F in prestrained material. (auth)

13172 (N-73-32800) STUDY OF CRACK CLOSURE IN FATIGUE. Final Report. Shih, T. T.; Wei, R. P. (Lehigh Univ., Bethlehem, Pa. (USA)). Oct 1973. 86p. (NASA-CR-2319; IFSM-72-25). NTIS $3.75.

Crack closure phenomenon in fatigue was studied by using a Ti–6Al–4V titanium alloy. The occurrence of crack closure was directly measured by an electrical-potential method, and indirectly by load-strain measurement. The experimental results showed that the onset of crack closure depends on both the stress ratio, and the maximum stress intensity factor. No crack closure was observed for stress ratio greater than 0.3 in this alloy. A two-dimensional elastic model was used to explain the behavior of the recorded load-strain curves. Closure force was estimated by using this model. Yield level stress was found near the crack tip. Based on this estimated closure force, the crack opening displacement was calculated. This result showed that onset of crack closure detected by electrical-potential measurement and crack-opening-displacement measurement is the same. The implications of crack closure on fatigue crack are considered. The experimental results show that crack closure cannot fully account for the effect of stress ratio on crack growth, and that it cannot be regarded as the sole cause for delay. (STAR)

13173 (ORNL-TM-4427) CREEP STUDIES ON TYPE 304 STAINLESS STEEL (HEAT 8043813) UNDER CONSTANT AND VARYING LOADS. Swindeman, R. W.; Pugh, C. E. (Oak Ridge National Lab., Tenn. (USA)). Jun 1974. Contract W-7405-eng-26. 55p. AT.

Initial studies to develop high-temperature structural design methods for LMFBR components have used material from a 1-in. plate of type 304 stainless steel (heat 8043813), which meets RDT standards. This material was studied while a large reference heat of type 304 stainless steel was being procured for comprehensive testing. Results of creep and tensile tests are reported along with experimental practices. The tests were conducted to characterize the fundamental material behavior and to provide limited but consistent information for assessing the applicability of constitutive equations and analysis methods. Tensile tests were performed at temperatures ranging from room temperature to 649°C, and the results are interpreted in terms of bilinear representations for strains in the range 0.1 to 1%. The Ludwik equation is used to describe the true-stress–true-strain behavior between 0.1% and the ultimate uniform strain. To characterize heat 8043813 relative to other heats of type 304 stainless steel, short-time creep–rupture tests were performed in the range 538 to 816°C. The data from these tests show that this heat possesses good strength and ductility and that the stress and thermal dependences of rupture life are quite high. Assuming the Norton equation to hold for representing the rupture data, the stress exponent is about 12 at 649°C. The apparent activation energy, based on the Dorn parameter, is 126,000 cal/mole for rupture and 157,000 cal/mole for the minimum creep rate. Exploratory creep tests extending to 2000 h were performed under both constant and variable loads. Although some tests were con-

ducted at other temperatures, the temperature of greatest emphasis was 649°C. The features of the primary creep curves under constant loading conditions are carefully examined and related to several strain-time expressions. Equations that are based on the existence of a transient primary creep strain are shown to be fairly representative of actual behavior. A set of consistent creep curves is presented for constant loads over a broad range of stresses. These curves are employed to evaluate the effectiveness of strain-hardening predictions of the creep response under varying loads. Within the accuracy of the strain measurements, the predictions generally appear reasonable. For complete unloadings, recovery strains were small and limited to values comparable to the elastic strain before unloading. Results of metallurgical examinations are given, including an examination of failure modes and surfaces. Examinations of both photomicrographs and transmission electron micrographs are presented. (46 fig, 9 tables) (auth)

13174 ADSORPTION OF CO ON THE (110) PLANE OF TUNGSTEN; TEMPERATURE DEPENDENCE OF THE STICKING COEFFICIENT AND ABSOLUTE SURFACE COVERAGES. Kohrt, C.; Gomer, R. (Univ. of Chicago). Surface Sci.; 40: No. 1, 71-84(Oct 1973).

Absolute coverages and sticking coefficients as functions of both gas and surface temperatures are presented for CO adsorption on the (110) plane of tungsten. For a low temperature layer the CO/W ratio at saturation is 1.1, while that for alpha or beta adsorption is 0.5, indicating some crowding in the low temperature phase at high coverage. Initial sticking coefficients drop with increasing gas or surface temperature but eventually level off at ~0.5. Qualitative reasons for this behavior are given. (auth)

13175 ELECTRON IMPACT DESORPTION OF HYDROGEN ON TUNGSTEN. I. Pure Hydrogen Lasers. Jelend, W.; Menzel, D. (Technische Univ., Munich). Surface Sci.; 40: No. 2, 295-310 (Nov 1973).

The electron impact induced desorption (EID) of H^+ ions from hydrogen layers on thermally annealed polycrystalline tungsten ribbons has been investigated mass spectrometrically. In agreement with Benninghoven [Benninghoven et al., J. Vacuum Sci. Technol. 9: (1972)] and Madey [Madey et al., Surface Sci. 9: (1972)] the more strongly bound β_2-state has been found to have a higher EID cross section than the more weakly bound β_1-state. Ionic and total desorption cross sections have been measured at 100 eV; the obtained values agree with the lower values published to date, which suggests that the much higher values reported by some workers do not apply to pure hydrogen layers. The contributions of the different states have also been investigated using partial coverage with deuterium. The implications of the findings for the understanding of the adsorption states of hydrogen on tungsten and for the mechanism of EID are discussed. (auth)

13176 STUDY OF OXIDE FORMATION AND ADSORPTION OF ALKALINE EARTHS ON OXYGEN-COVERED SURFACES OF TUNGSTEN USING SURFACE IONIZATION. Mueller, R.; Wassmuth, H. W. (Univ., Marburg, Ger.). Surface Sci.; 40: No. 1, 15-36(Oct 1973). (In German).

The surface ionization of alkaline-earth elements on tungsten has been studied as a function of dependence on the temperature T and the surrounding oxygen partial pressure p_{O_2}; the values of the ionization efficiency β together with those of the change of the work function $\Delta\Phi$ of the surface have been applied to get information about chemical reactions of the incident alkaline-earth atoms with adsorbed oxygen and about the adsorption of alkaline-earth elements on tungsten. Whereas in the high temperature range the tungsten surface is clean, towards lower temperatures (i.e. below ≈2500°K at $p_{O_2} = 1 \times 10^{-6}$ torr or below ≈2000°K at $p_{O_2} = 1 \times 10^{-9}$ torr), an adsorption of oxygen increases the work function Φ and, consequently, the ionization efficiency β of incident metal atoms. A characteristic feature of the surface ionization of the alkaline-earth elements, however, is a rapid re-decrease of β with further decreasing temperature, which occurs at $T \approx 1400$°K for Mg/W, $T \approx 1600$°K for Ca/W, $T \approx 1800$°K for Sr/W, and at $T \approx 2000$°K for Ba/W. It is shown that this behavior of β is caused by two different reasons: Whereas in the case of Mg/W a substantial Mg adsorption leading to a reduction of the work function is responsible for the decrease of β solely, and β values of Ca and Sr are additionally influenced by chemical reactions of the incident metal atoms with adsorbed oxygen resulting in an alkaline-earth oxide desorption. In the system Ba/W the decrease of the ionization efficiency β can be referred to BaO formation exclusively. Assuming a thermodynamic equilibrium between the different adparticles and using experimental values of the dissociation energy of the alkaline-earth oxides (in the gas phase), the results are in good agreement with theoretical calculations. (auth)

13177 CHANGE IN NORMAL SPECTRAL EMITTANCE (at 650 nm) OF NIOBIUM DURING MELTING AND ITS RELATION TO SURFACE ROUGHNESS. Cezairliyan, A. (National Bureau of Standards, Washington, DC). Surface Sci.; 40: No. 2, 429-432(Nov 1973).

Investigations on the behavior of the normal spectral emittance (at 650 nm) of niobium during melting are described. An attempt is made to relate the difference between the emittances of solid and liquid niobium at the melting point to the roughness of the solid surface. Experimental results are summarized tabularly and graphically. The fact that emittance difference approaches zero as the roughness parameter approaches zero indicates that the primary reason for a change in emittance during melting is the change in surface conditions and not the change in the intrinsic properties of the specimen. This may be said to apply to niobium based on the results of a limited number of experiments. (JRD)

13178 ADSORPTION OF COPPER ON TUNGSTEN: MEASUREMENTS ON SINGLE CRYSTAL PLANES. Polanski, J.; Sidorski, Z. (Univ., Wroclaw). Surface Sci.; 40: No. 2, 282-294(Nov 1973).

Work function changes caused by depositing and spreading of copper were measured on the (110), (100), (111) and (211) faces of tungsten crystal by means of field emission microscope. On (110) and (100) faces the work function for low coverage decreases with increasing amount of copper deposited, passes through a minimum, then increases for higher coverage and saturates for a thick layer. On (111) and (211) faces in the low coverage range, the work function increases when the amount of adsorbed copper increases. After reaching a maximum value the changes in work function on these planes have the same character as on (110) and (100) planes, i.e. the work function drops down when the coverage increases, passes through a minimum, increases again and saturates for a thick layer. It is proposed to connect the increase of work function on (111) and (211) faces at low coverage with the loose structure of the substrate surface. The adsorption of copper on these planes causes the smoothing of the crystal surface and this can lead to enhancement of the work function. The performed calibration of the coverage shows that changes in work function are occurring during formation of the first layer of copper adatoms. (auth)

13179 RECONSTRUCTION AT A METALLIC INTERFACE STUDIED BY FIELD ION AND FIELD EMISSION MICROSCOPY. Cetronio, A.; Jones, J. P. (University Coll. of North Wales, Caernarvonshire, Eng.). Surface Sci.; 40: No. 2, 227-248(Nov 1973).

Reconstruction of a tungsten surface by adsorbed layers of gold, silver, and copper has been studied by field emission and field ion microscopy. Gold reconstructs the surface in three ways, termed the α, β, and γ rearrangements. The α rearrangement, which results in a smoothing of the tungsten surface, takes place at around 400°K with gold coverages of 5 monolayers (5θ), and is thought to be an increase in structural perfection of the tungsten surface by gold-assisted surface diffusion of tungsten atoms. β-reconstruction takes place in the temperature range 480 to 950°K at coverages $\geq 1.7\theta$, producing a faceted surface which comprises {211} and {110} facets, and is thought to result from the need to minimize the free energy at the gold/tungsten interface. The γ structure, which appears above 1400°K, is believed to represent a change in the shape of the tip by transport of tungsten to the (110) locality. Adsorbed silver produces neither β nor γ structures, and the degree of α rearrangement is very small, being confined to the {230} regions of the substrate. Copper lies between silver and gold in its ability to rearrange the tungsten surface, some degree of α rearrangement is detectable, and the β structure is very poorly developed unlike the γ structure which is clearly formed. The binding strength of copper to tungsten is greater than that of silver, but less than that of gold; the capacity of an adsorbate to reconstruct the tungsten substrate is therefore thought to be related to the strength of the adsorbate–substrate bond. (auth)

13180 RELATIVISTIC THEORY OF LOW ENERGY ELECTRON DIFFRACTION: APPLICATION TO THE (001) AND (110) SURFACES OF TUNGSTEN. Feder, R. (Univ. of Cape Town). Phys. Status Solidi (b); 62: No. 1, 135-146(1 Mar 1974).

A relativistic theory for calculating low energy electron diffraction intensities and spin polarization properties is applied to the (001) and (110) surfaces of tungsten for several angles of incidence. Intensity-energy profiles are obtained in generally good agreement with experimental data. Relativistic effects on intensities are found to be noticeable, and appreciable spin polarization features are predicted. In particular, large degrees of spin polarization in conjunction with sizeable intensities are found in the specular beam for large angles of incidence on W(001). (auth)

13181 s–d BOND AND THE LOCALIZED MAGNETIC MOMENT IN THE SOLID SOLUTIONS OF TRANSITION METALS.

Galperin, F. M.; Kizhaev, F. G.; Shvedkov, V. I. (State Univ. of Mordov, USSR). Phys. Status Solidi (b); 62: No. 1, 313-318(1 Mar 1974).

The role of the s–d bond is considered in the formation of the magnetic moment of the 3d-transition elements dissolved in 4d-metals. It is shown that in consequence of the s–d bond the Coulomb interaction of the 3d-electrons on an impurity atom is reduced by about 15 to 20% in comparison with a free atom. (auth)

13182 COMMENTS ON THE PROBABLE ELECTRONIC STRUCTURE OF THE GROUP II POLONIDES. Dalven, R. (Univ. of California, Berkeley). Phys. Status Solidi (b); 62: No. 1, K5-K7(1 Mar 1974).

Data on the electronic structure of Group II polonides were examined. It is suggested, based on empirical evidence, that the polonides of calcium, strontium, and barium are semiconductors and that their bonding is strongly ionic in nature. The polonides of calcium and zinc are very likely similar in their electronic structure to the corresponding chalcogenides with the zinc-blende structure. However, HgPo is probably qualitatively different in its band structure from HgTe. (JRD)

13183 HYPERFINE INTERACTIONS IN Y_6Fe_{23} COMPOUND. Morariu, M.; Burzo, E.; Barb, D. (Inst. for Atomic Physics, Bucharest). Phys. Status Solidi (b); 62: No. 1, K55-K58(1 Mar 1974).

Results of Mössbauer effect measurements on Y_6Fe_{23} to reveal its magnetic properties are presented. Data and discussions are included on atomic sites in the molecule, Mössbauer spectra of ^{57}Fe in Y_6Fe_{23}, thermal variation of hyperfine fields, quadrupole splittings, center shifts, and Fe mean magnetic moment. (JRD)

13184 PROPERTIES OF THE SLIGHTLY ALLOYED ALLOYS OF THE Cu–Cr–Zr SYSTEM. Revina, N. I.; Novikov, A. I.; Nikolaev, A. K.; Rozenberg, V. M. Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 6, 106-110(1973). (In Russian).

From the study of the effect of the ratio of Cr and Zr on the hardening of alloys containing 99.6 wt % Cu it was shown that in the Cu–Cr–Zr system in the composition range studied an abnormal change in the properties was not observed at Zr and Cr concentrations corresponding to the formation of the compound $ZrCr_2$. The hardening observed after processing by tempering, deformation, and aging in Cu–Cr alloys with small additions of Zr (up to 0.1 wt %) is explained by the characteristics of their fine structure. Increase in the Zr content above 0.1 wt % is inadvisable. Alloys of Cu with 0.33% Cr and 0.07% Zr after tempering, cold working, and aging have a tensile strength of about 60 kg/mm^2 with an electric conductivity no less than 90% of the electric conductivity of Cu. The ductility of the ternary alloys is high in the temperature interval studied. (tr-auth)

13185 INVESTIGATION OF THE SOLUBILITY OF CARBON IN THE ALLOY Mo + 45% Re. Savitskii, E. M.; Tylkina, M. A.; Konieva, L. Z.; Lonunov, A. V.; Petrushin, N. V. (Inst. of Metallurgy, Moscow). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 6, 125-129(1973). (In Russian).

By measurement of the electric resistivity at high temperatures it was shown that the solubility of C in Mo + 45% Re is 0.035% at 1550 and reaches 0.05% at 1800°C. It was established that in the presence of 45% Re the solubility of C in Mo is increased to 25% at 1800 and to 75% at 1550°C. It was shown that the migration of C in the solid solution causes a significant increase of the electrical resistance of the alloy (the presence of 0.035% C in the solid solution increases ρ to 7.5 $\mu\Omega \cdot$ cm). The presence of carbides in the alloy (at C concentrations up to 0.265%) does not significantly affect the size of its specific electrical resistance. The temperature coefficient of the specific electric resistance of the alloy Mo + 45% Re at 1000 to 1800°C can be considered constant and equal to 29×10^{-3} $\mu\Omega \cdot$ cm/°C. The migration of 0.035% C in the solid solution leads to a reduction of the temperature coefficient of the electrical resistance. At temperatures much lower than the temperature of complete dissolution of C in the alloy, the temperature coefficient of the electrical resistance increases slightly with increase of temperature. The presence of discontinuities in the electrical resistance curve of the Mo + 45% Re + 0.4% C was established at 1250 to 1260°C. (tr-auth)

13186 DETERMINATION OF THE DIMENSIONS OF PRECIPITATES DURING THE DECOMPOSITION OF THE SOLID SOLUTION IN THE ALLOY Al + 0.4% Zr BY THE METHOD OF SMALL-ANGLE X-RAY SCATTERING AND ELECTRON MICROSCOPY. Klimovich, L. G.; Vainblat, Yu. M.; Ovechkin, B. I.; Ber, L. B. Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 6, 135-137(1973). (In Russian).

The decomposition of the solid solution in the Al + 0.4% Zr alloy was studied by small-angle x-ray scattering. The dimensions of two fractions revealed from analysis of the scattering curves are tabulated. Electron microscopic studies revealed the precipitates to be spherical. Evaluation of the relative volumes of the different fractions led to the conclusion that the quantity of very coarse fraction increases with the duration of aging. (JSR)

13187 THERMOPHYSICAL PROPERTIES OF RHENIUM AT HIGH TEMPERATURES. Vertogradskii, V.A.; Chekhovskoi, V.Y. (High-Temperature Institute, Academy of Sciences of the USSR). High Temp. 11: No. 1, 71-74 (Sept 1973).

The electrical resistivity, thermal conductivity, and total hemispherical emissivity of polycrystalline rhenium have been measured over the temperature range 1200-3000°K. Some reasons for the discrepancies between the results of various authors are discussed. (auth)

13188 STUDY OF THE CONDITIONS UNDER WHICH THE OMEGA PHASE FORMS IN TITANIUM–NIOBIUM AND TITANIUM–MOLYBDENUM ALLOYS. Morniroli, J. P. (Ecole National Superieure, Nancy). Mem. Sci. Rev. Met.; 70: No. 11, 831-842(Nov 1973). (In French).

From autumn meeting on metallurgy; Chatenay-Malabry, France (2 Oct 1972).

The ω phase appears immediately after rapid cooling from the β domain (athermic omega) or by aging of the β phase (tempering omega). In the Ti–Nb alloys examined, the formation of athermic ω is hindered by the martensitic $\beta \rightarrow \alpha'$ and $\beta \rightarrow \alpha''$ transformations. On the other hand, Ti–Mo alloys present two types of ω phase. (FR)

13189 ELECTRONIC SUSCEPTIBILITY OF NIOBIUM. Cooke, J.F.; Davis, H.L.; Mostoller, M. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge Tennessee 37830). Phys. Rev. B 9: No. 6, 2485-2489 (15 Mar 1974).

The static electronic susceptibility χ ($\vec{q}$) is calculated for niobium along the [100] direction both with and without matrix elements. The energy bands are generated by a fitted second neighbor, s–p–d Slater–Koster model, and matrix elements are approximated by using the Slater–Koster wave–function coefficients with radial integrals of Fermi–level Korringa–Kohn–Rostoker wave functions within the muffin tin. The Brillouin–zone integration is carried out by the combined linear–quadratic method of Cooke and Wood. Contrary to the work of Evenson, Fleming, and Liu our constant–matrix–element calculation yields a result for χ ($\vec{q}$), which is relatively featureless. The major effects of including the band and momentum dependence of the matrix elements are to make χ ($\vec{q}$) a generally decreasing function of $|\vec{q}|$, and to bring out some structure not seen in the constant–matrix–element calculation. The static susceptibility has a noticeable hump around the same wave vector as the observed [100] LA–phonon anomaly. The frequency dependence of the real part of the dynamic susceptibility appears to be small for ω in the phonon–frequency range. (auth)

13190 TEMPERATURE DEPENDENCE OF THE CARRIER MEAN FREE PATH IN TIN BY THE RADIO–FREQUENCY SIZE EFFECT. Hughes, G.P.; Merrill, J.R. (Department of Physics and Astronomy, Dartmouth College, Hanover, Massachusetts 03755). Phys. Rev. B 9: No. 6, 2423-2432 (15 Mar 1974).

The temperature dependence of the carrier mean free paths in tin have been measured by means of the amplitude dependence of the radio–frequency size effect on temperature. Data on the mean free path for the temperatures from 2 to 8 K are presented as measured by extremal orbits. These measurements were made for calipers in the plane perpendicular to the [010] direction. The temperature–dependent part of the mean free path was found to obey $1/l(T) = QT^s$. Anisotropy in both Q and a were found. Much of the Fermi surface obeyed a T^3 law, but the exponent a for the fourth–zone hole surface varied from 4.5 to 5.6 depending on the caliper and the direction of the magnetic field. (auth)

13191 NON–MUFFIN–TIN EFFECTS IN THE 4d TRANSITION METALS Rb, Nb, AND Pd. Painter, G.S.; Faulkner, J.S.; Stocks, G.M. (Metals and Ceramics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). Phys. Rev. B 9: No. 6, 2448-2456 (15 Mar 1974).

While the effects of corrections to the muffin–tin model of the crystal potential have been investigated fairly thoroughly for various insulators and semiconductors, relatively few complete calculations have been done for transition metals. The Hartree–Fock–Slater muffin–tin approximate potential is usually adequate for characterization of the general properties of free–electron metals. In the transition–metals series, however, where the Fermi energy typically lies in a partially filled d band, it is recognized that small nonuniform energy shifts can appreciably alter the properties dependent upon the detailed topology of the Fermi surface. Here, we report the application of the recently proposed combined Korringa–Kohn–Rostoker discrete variational method for several crystals representative of the 4d transition–metal series. Results are analyzed directly in terms of the Bloch wave functions and various trends and general features of non–muffin–tin effects in the transition metals are determined. (auth)

13192 NIOBIUM FERMI SURFACE AND THE MAGNETOACOUSTIC INTERACTION: POLARIZATION SELECTIVITY. Leibowitz, J.R.; Blessing, G.V. (Department of

Physics, Catholic University, Washington, D. C.); Alexander, E.M. Phys. Rev. B 9: No. 6, 2457-2466 (15 Mar 1974).

The magnetoacoustic interaction for field H normal to propagation vector $\vec{q}$ has been studied in high-purity niobium at frequencies extending to 650 and 430 MHz for longitudinal and transverse waves, respectively. Fermi-surface calipers determined for $\vec{q} \| [100]$ and $\vec{e} \| [010]$ agree within about 2% with the augmented-plane-wave theoretical values for the distorted ellipsoids. Also, an interesting and useful "caliper-selectivity" mechanism operative in the transverse-wave case was observed which, for particular orientations of wave polarization $\vec{e}$, served to isolate individual calipers so that the calipers corresponding to a single Fermi sheet were swept out as H was rotated through 360°. The corresponding presence of a single period in the oscillations at all field angles permitted relaxation of the number of oscillations required for precise determination of the electron momenta. (auth)

13193 DETERMINATION OF THE EXCHANGE ANISOTROPY AND THE ONE-ION ANISOTROPY IN Tb, Dy, Ho, Er, AND Tm. Boutron, P. (Laboratoire de Magnétisme, Centre National de la Recherche Scientifique, B. P. 166, 38042-Grenoble-Cedex, France). Phys. Rev. B 9: No. 7, 2971-2980 (1 Apr 1974).

The contributions of the exchange anisotropy and of the one-ion anisotropy to the total anisotropy are determined in Tb, Dy, Ho, Er, and Tm. The contribution of the one-ion anisotropy is deduced from that of rare-earth-doped gadolinium single crystals. The exchange anisotropy is then obtained from the difference from the anisotropy of pure-rare-earth metals. The exchange anisotropy is about -1/2 of the one-ion anisotropy. The variation of the one-ion anisotropy from one rare earth to another has been calculated using a screened-point-charge model. The variation of the exchange anisotropy has been calculated from a theoretical Hamiltonian using an exact expression of the paramagnetic susceptibility given in a previous paper. The theoretical and experimental variations of the two anisotropies are in good agreement for most of the rare earths. (auth)

13194 CRYSTAL-FIELD MAGNETIC ANISTOTROPY OF DILUTE DYSPROSIUM OR ERBIUM IN YTTRIUM SINGLE CRYSTALS. Høg, J.; Touborg, P. (Department of Electrophysics, The Technical University of Denmark, DK-2800 Lyngby, Denmark). Phys. Rev. B 9: No. 7, 2920-2928 (1 Apr 1974).

Magnetization measurements have been performed between 1.3 and 300 K in fields up to 50×10^5 A/m in the a, b, and c directions of hcp crystals of pure Y and Y doped with 0.14-at.% Dy or 0.14-at.% Er, using the Faraday method and a vibrating-sample method. The characteristic behavior of both the isothermal and isofield susceptibility curves could be interpreted in terms of a general single-ion anisotropy Hamiltonian and a molecular-field exchange model. In this way the following anisotropy parameters $A_{nm}\langle r^n \rangle$, with (n, m) = (2, 0), (4, 0), (6, 0), and (6, 6) respectively, were obtained (in units of K): Er, -122 ± 12, $+18.3 \pm 1.8$, $+11.7 \pm 1.2$, -135 ± 13; Dy, -30.5 ± 5, $+49.5 \pm 5$, $+40.4 \pm 4$, -321 ± 32. The higher-order anisotropy parameters play an important part in determining the crystal-field-level scheme and they are incompatible with a model assuming that the charges giving rise to the crystal field are solely external to the magnetic ion. The exchange interactions differ by up to a factor of 15 for c and basal-plane directions. (auth)

13195 INTERACTION OF OXYGEN AND NITROGEN WITH THE NIOBIUM(100) SURFACE. I. Morphology. Farrell, H. H.; Strongin, M. (Brookhaven National Lab., Upton, NY). Surface Sci.; 38: No. 1, 18-30(Jul 1973).

Low energy electron diffraction has been used to investigate the reactions between nitrogen and oxygen and the (100) face of niobium. Several different oxygen containing surface structures were observed. (auth)

13196 INTERACTION OF OXYGEN AND NITROGEN WITH THE NIOBIUM(100) SURFACE. II. Reaction Kinetics. Farrell, H. H.; Isaacs, H. S.; Strongin, M. (Brookhaven National Lab., Upton, NY). Surface Sci.; 38: No. 1, 31-52(Jul 1973).

Auger spectroscopy has been used to investigate the interactions of oxygen and nitrogen with both the (100) face niobium and with polycrystalline niobium. Sticking coefficients for both gases have been determined as a function of coverage. A temperature and concentration dependent segregation of oxygen at the surface has been observed even under conditions where the solid solubility of the bulk was not exceeded. A model to describe this segregation has been developed and extended to explain discrepancies in earlier investigations of the reaction of oxygen with niobium. (auth)

13197 NIOBIUM CORNER OF SYSTEM Nb-Co-Pt. Statnova, E. A.; Kuprina, V. V. Vestn. Mosk. Univ., Ser. II. Khim.; 15: No. 1, 115-117(1974). (In Russian).

The isothermal cross section was constructed for the system Nb-NbCo-NbPt at 1000°C. (auth)

13198 EFFECT OF FAST NEUTRON IRRADIATION ON THE OPTICAL MODULATION SPECTRA OF GaAs. Tuomi, T.; Tiainen, O. J. A. (Helsinki Univ. of Tech.). Surface Sci.; 37: 617-622 (Jun 1973).

From proceedings of the first international conference on modulation spectroscopy; Tucson, AZ (23 Nov 1972).

The electroreflectance and wavelength-modulated reflectance spectra of GaAs were measured before and after several reactor irradiation periods. High resistivity n type GaAs crystals were irradiated at a temperature between 300 and 310°K up to a fast neutron fluence of 3.3×10^{17} n/cm^2. The E_0 and $E_0 + \Delta_0$ peaks shift nonlinearly toward lower energy, the change reaching a maximum value of about -50 meV at 10^{17} n/cm^2. At this fluence an additional peak appears at 1.33 eV. The E_1 and $E_1 + \Delta_1$ peaks move almost linearly toward higher energy with increasing fast neutron fluence, the shift being about +25 meV at 2×10^{17} n/cm^2. The results are discussed taking into account infrared absorption measurements and the calculations made by McNichols, Hayes, and Ginell concerning the metallic GaAs precipitates. The effect of possible internal stress produced by the fast neutron bombardment on the modulation spectra is also discussed. (auth)

13199 DIRECTIONAL PHOTOEMISSION FROM TUNGSTEN. Feuerbacher, V.; Fitton, B. (European Space Research Organization, Noordwijk, Netherlands). Surface Sci.; 37: 386-394(Jun 1973).

From proceedings of the first international conference on modulation spectroscopy; Tucson, AZ (23 Nov 1972).

Photoemission energy distribution spectra have been scanned for photoelectrons emitted normal to two different crystal faces of tungsten, namely (100) and (110). The energy distributions and the derivative spectra show large differences between emission from the two faces. Whereas strong surface state emission is observed from the (100) face, no surface states are associated with the (110) face. The spectra show features characteristic of direct and also nondirect transitions, but these features appear very different for the two faces. Using existing band structure calculations, the spectral structure is assigned to electronic transitions between bands along the Δ axis for the (100) face and the Σ axis for the (110) face. Results of the experiments show that directional photoemission spectra taken normal to a crystal surface make it possible to investigate electronic energy bands along symmetry directions in the Brillouin zone. (auth)

13200 DESORPTION OF K^+ FROM MOLYBDENUM. Thapliyal, H. V. (Univ. of Idaho, Moscow); Stefanakos, E. K.; Tinder, R. F. Surface Sci.; 38: No. 1, 231-233(Jul 1973).

Determination of the desorption energy of K^+ from Mo by measuring the peak temperature of each of several linear temperature sweep rates is reported. The mean ionic adsorption lifetime of K^+_{39} on polycrystalline Mo was found to be 2×14^{-14}s and the ionic activation energy 2.53 ± 0.10 eV. (JRD)

13201 CHEMISORPTION OF CO ON TUNGSTEN(100): COMBINED FLASH DESORPTION AND ELECTRON STIMULATED DESORPTION STUDY. II. Yates, J. T. Jr.; King, D. A. (Univ. of East Anglia, Norwich, Eng.). Surface Sci.; 38: No. 1, 114-128 (Jul 1973).

The chemisorption of CO on W(100) at ~ 100°K has been studied using a combination of flash desorption and electron stimulated desorption (ESD) techniques. This is an extension of a similar study made for CO adsorption on W(100) at temperatures in the range 200 to 300°K. As in the 200 to 300°K CO layer, both α_1-CO and α_2-CO are formed in addition to more strongly bound CO species upon adsorption at ~100°K; the α-CO states yield CO^+ and O^+ respectively upon ESD. At low CO coverages, the α_1 and α_2-CO states are postulated to convert to β-CO or other strongly bound CO species upon heating. At higher CO coverages, α_1-CO converts to α_2-CO upon thermal desorption or electron stimulated desorption. There is evidence for the presence of other weakly-bound states in the low temperature CO layer having low surface concentration at saturation. The ESD behavior of the CO layer coadsorbed with hydrogen on W(100) is reported, and it is found that H(ads) suppresses either the concentration or the ionic cross section for α_1 and α_2-CO states. (auth)

13202 KINEMATIC ANALYSIS OF RHEED INTENSITIES FROM THE $O_2(2 \times 1)$-W(110) SURFACE STRUCTURE. Matysik, K. J. (Cornell Univ., Ithaca, NY). Surface Sci.; 38: No. 1, 93-113(Jul 1973).

Kinematic electron diffraction theory was used to analyze reflection high energy electron diffraction (RHEED) intensities from the $O_2(2 \times 1)$-W(110) surface structure. An expression was derived enabling comparison of kinematic theory with experimental absolute integrated intensities. To justify the use of kinematic theory diffraction conditions were found under which there appeared to be a dynamical decoupling of beams scattered by the substrate from those of the surface structure. Under these diffraction conditions reasonable agreement between theory and experiment was obtained using a surface structure model proposed

by Bauer. The surface structure model proposed by Germer and May did not adequately describe the observed intensities and it was concluded that the Bauer model was the more plausible representation of the surface. (auth)

13203 VALIDITY OF THE FOWLER–NORDHEIM PARAMETERS MEASURED FOR SILICON ADSORPTION ON SINGLE CRYSTAL FACES OF TUNGSTEN. *Collins, R. A.* (Univ. of Lancaster, Eng.). Surface Sci.; 40: No. 3, 470-478(Dec 1973).

The adsorption of silicon on the (112), (111), (100), (110), (113), and (116) planes of tungsten field emitters has been studied. As with Ge and CdS adsorption, anomalous behavior of the Fowler–Nordheim parameters A and ϕ was observed together with non-linearity in the Fowler–Nordheim plots. This non-linearity is not explicable in terms of the theories proposed for bulk semiconductors. The results support the suggestion that field-induced Si migration from the W substrate is responsible for anomalies in the F–N parameters. (auth)

13204 MODELS FOR AN ADSORBED LAYER AND THEIR EVALUATION BY COMPARISON OF LEED AND OPTICAL DIFFRACTION PATTERNS: THE SYSTEM W(112)–O_2. McKee, C. S.; Perry, D. L.; Roberts, M. W. (Univ. of Bradford, Eng.). Surface Sci.; 39: No. 1, 176-205(Aug 1973).

The LEED patterns produced by the system W(112)–(2 × 1)–O at $\theta < 0.5$ are known to consist of sharp integral and streaked half order features and have been previously interpreted in terms of separate islands of adsorbed oxygen out of phase with each other in the [11$\bar{1}$] direction. The diffraction properties of various structures of this type are examined theoretically and by optical diffraction methods using laser light. The results show that if the island model is correct, integral order spots would be streaked in addition to those of half order. An alternative model is therefore developed which correctly simulates the LEED patterns. On the basis of a number of assumptions regarding the formation of a mobile precursor layer, diffusion mechanism and diffusion distances within this layer, and attractive forces between adsorbed and diffusing species, a simple statistical method is used to follow the progress of individual molecules between gas phase and final adsorption site. The resulting adsorbate layer consists of out of phase regions, many of which are in contact even at low coverage; vacant sites are permitted at random positions within each region. Changes which have been observed in details of the LEED patterns at high (2 × 1) coverage are shown to be consistent with an adsorbate rearrangement leading to elimination of the antiphase boundaries. (auth)

13205 DETERMINATION OF WORK FUNCTIONS NEAR MELTING POINTS OF REFRACTORY METALS BY USING A DIRECT-CURRENT ARC. Gordon, W. A.; Chapman, G. B. II. (Lewis Research Center, Cleveland). Surface Sci.; 39: No. 1, 121-135(Aug 1973).

A direct-current arc in argon at atmospheric pressure was used to determine effective work functions of refractory metals, including tantalum, tungsten, molybdenum, and niobium. The procedure is experimentally advantageous because surface cleanliness of the specimen is not critical, high vacuum is not required, and the anode–cathode spacing is not critical. The experimental procedure involves striking an arc to a metal wire cathode to form a melted ball having an emitting area defined by its diameter. The literature melting point of the metal is taken as the emitting temperature. By using these parameters and the known arc current, effective work functions agree with recommended handbook values to within about 0.1 V and have typical repeatabilities of 0.02 V. By varying the arc current, Richardson plots can be made over a temperature range from a few hundred degrees below the melting point to about 50°K over the melting point of the test metal. A Richardson plot over this temperature range is presented for tantalum. (auth)

13206 FIELD EMISSION ENERGY DISTRIBUTION (FEED) STUDY OF ELECTRON INTERACTIONS IN TUNGSTEN Czyzewski, J. J. (Univ., Wroclaw). Surface Sci.; 39: No. 1, 1-20(Aug 1973).

Field Emission Energy Distributions (FEED) have been measured along the [001], [016], and [013] directions of a tungsten crystal within the temperature range 78 < T < 950°K Both electron–phonon interactions and band structure effects have been considered as a function of the crystallographic orientation. Measurements over a wide range of temperatures have been interpreted in terms of both electron–d hole and electron–phonon interactions. The comparison of measurements along [001], i.e. the emission mainly from the d band with those previously published along [012], i.e. the emission mainly from the s band, is consistent with the postulated s → d transitions directly. Under conditions in which electron–phonon scattering occurs, the relation of FEED to the Nottingham effect has been investigated. In the light of electron transport phenomena in tungsten the calculation of the inversion temperature seems to require a new theoretical procedure. (auth)

13207 COMPARISON OF THE EFFECTS OF OXYGEN ON THE ION EMISSION AND SURFACE POTENTIAL OF METALS. Blaise, G.; Slodzian, G. (CNRS, Orsay, France). Surface Sci.; 40: No. 3, 708-714(Dec 1973). (In French).

Secondary ions produced by ion bombardment are analyzed for energy with the help of the electrostatic mirror in the ion-microanalyzer. This method is used to measure the work function of pure metals and bulky alloys and to follow the evolution of the surface potential during gas adsorption. In addition, it is shown that the enhancement of the ion emission of oxygen by a metal does not result from surface potential changes. The origin of the enhancement rather proceeds from the ionic character of metal–oxygen bonds that promotes direct expulsion of ions. (auth)

13208 STABILITY OF W_2 AND WRe ADATOM CLUSTERS ON (110) TUNGSTEN SURFACES. Bassett, D. W.; Tice, D. R. (Imperial Coll. of Science and Tech., London). Surface Sci.; 40: No. 3, 499-511(Dec 1973).

Kinetics of formation and dissociation of W_2 and WRe adatom clusters and dissociation reaction equilibria on (110) W were studied by field ion microscopy. Deposits of two adatoms only on the (110) face of a tungsten field ion microscopy (FIM) tip were used and these reached an equilibrium state at 400°K. For the W_2 dissociation reaction $\Delta A^{\ominus}(430°K) = 30 \pm 5$ kJ mol^{-1}; for WRe dissociation $\Delta A^{\ominus}(400°K) = 14 \pm 2$ kJ mol^{-1}. The dissociation energies indicated by kinetics were consitent with these values. (auth)

13209 PREDICTION OF TRANSITION METAL PHASE DIAGRAMS. Brewer, L. (Univ. of California, Berkeley). J. Nucl. Mater.; 51: No. 1, 2-11(May 1974).

The design of nuclear fuels and their containers, moderating materials of reactors, heat-exchanger materials, fission-product control, and fuel processing systems requires knowledge of the thermodynamics and phase relations not only of the actinide elements and their compounds but also of many other elements of the periodic table, particularly the transition metal elements. A discussion is presented which deals with methods of predicting the thermodynamics and phase diagrams of the transition metals, lanthanides, and actinides and is based largely on the first three references. These publications provide additional references that give more detail. The fourth reference, dealing with the existence of intermetallic compounds of extraordinary stability, may also be of interest. A paper by Sasaki entitled "Alloy Design" provides an example published in Japanese of the application of the ideas to be discussed. It is not possible in the space allotted to cover the methods of predicting transition metal phase diagrams in great detail. The general principles are reviewed and some sample applications illustrated. (auth)

13210 THERMODYNAMICS OF URANIUM INTERMETALLIC COMPOUNDS BY SOLID ELECTROLYTE EMF METHOD. Kanno, M. (Tokyo Univ.). J. Nucl. Mater.; 51: No. 1, 24-29(May 1974).

The standard Gibbs energies of formation of UFe_2, UCu_5, and U_2Co_{11} were determined using galvanic cells incorporating a solid calcium fluoride electrolyte. Calcium fluoride is an ionic conductor over the temperature range of the measurements. From the EMF values, the standard Gibbs energies of UFe_2, UCu_5, and U_2Co_{11} were calculated and the results are tabulated. (JRD)

13211 THERMODYNAMIC PROPERTIES OF BINARY THORIUM SYSTEMS. Smith, J. F. (Ames Lab., IA). J. Nucl. Mater.; 51: No. 1, 136-148(May 1974).

The available thermodynamic data for binary metallic systems of thorium have been critically reviewed. Data for the Th–O and Th–F systems have been included rather arbitrarily because of the importance of such data in deriving thermodynamic functions from equilibrium studies. Data for 53 intermediate phases in 19 binary systems are included. Within a given system, bits of information were evaluated with consistency as the paramount criterion and with reliability of experimental technique as the secondary guideline. (auth)

13212 INTERACTION BETWEEN A VACANCY AND IMPURITY ATOMS. Masuda, K. (Tokyo Inst. of Tech.). Phys. Status Solidi (b); 62: No. 2, 559-571(1 Apr 1974).

The vacancy-impurity interaction energy is calculated on the Wolff-Clogston model using the Hartree-Fock approximation. It is suggested that if a bound state exists below the band bottom and if most of the excess electrons are localized at the impurity sites, the interaction energy tends to become negative. There is a qualitative agreement between the theory and the experimental results in Fe base alloys with 3d-transition metal impurities. The interaction due to the magnetic origin inherent in the host metal structure is also taken into account using the simple Stoner model. (auth)

13213 PECULIARITIES OF THE ELECTRONIC STRUCTURE OF V_3Pd EXHIBITED IN THE X-RAY EMISSION SPECTRA OF THE CONSTITUENTS. Kurmaev, E. Z.; Sorokina, M. F. (Inst. of Metal Physics, Sverdlovsk, USSR). Phys. Status Solidi (b); 62: No. 2, K99-K102(1 Apr 1974).

It is noted that the valence band of the V_3Pd alloy consists of two slightly overlapping subbands of quite certain origin: the bottom of the band arises from Pd4d-states, and the high-energy part is formed mainly of V3d-states. This model is applied to the constituent x-ray L-spectra of V_3Pd for use as a basis in explaining why the d-states of palladium are displayed in a more pronounced way in the vanadium L-spectrum than the d-states of vanadium in the palladium L-spectrum where only a slight increase of the high-energy intensity is found with respect to the pure Pd spectrum. Expressions are developed to describe the structural and spectral phenomena. (JRD)

13214 PRESSURE DEPENDENCE OF THE FERMI SURFACE OF CADMIUM. Bryant, H.J.; Vuillemin, J.J. (Department of Physics, University of Arizona, Tucson, Arizona 85721). Phys. Rev. B 9: No. 8, 3193-3196 (15 Apr 1974).

We report measurements for the effects of hydrostatic pressure on several cross-sectional areas for the electron and for the hole sheets of the Fermi surface of Cd. Pressure derivatives were obtained at a temperature of 0.4 K using a fluid-He phase-shift technique in which the data are digitally recorded and analyzed. Calculations based on a semiempirical nonlocal pseudopotential band structure due to Stark are compared with the experimental results. The anisotropy observed in the pressure dependence of the electron sheet confirms the negative sign of the [0002] pseudopotential in this model. The pressure derivative of largest magnitude is for the [1120] cross section of the cap and is given by $d(\ln S)/dp = -(13.0 \pm 0.2) \times 10^{-3}$ kbar^{-1}. (auth)

13215 PHONONS, SADDLE POINTS, AND RESONANCES IN Nb. Chui, S.T. (Joseph Henry Laboratories of Physics, Princeton University, Princeton, New Jersey 08540). Phys. Rev. B 9: No. 8, 3300-3306 (15 Apr 1974).

The dip observed in the [100] branch in Nb and its absence in Mo is ascribed to the d-p intervalley electron-phonon scattering of electrons near the saddle points at (0.5, 0.5, 0) π/a; to states near (0.5, -0.5, 0) π/a (but outside the Fermi surface) and corresponding symmetry combinations. (auth)

13216 LOCALIZED WAVE FUNCTIONS IN THE THEORY OF COHESION. III. MODEL CALCULATIONS FOR THE ALKALINE EARTHS AND CADMIUM. Kalkan, R.; Girifalco, L.A.; Rothwarf, A. (School of Metallurgy and Materials Science, and Laboratory for Research on the Structure of Matter, University of Pennsylvania, Philadelphia, Pennsylvania 19174). Phys. Rev. B 9: No. 8, 3187-3192 (15 Apr 1974).

Model calculations of the cohesive properties of the alkaline earths and cadmium were performed using a bond approach to metals based on localized wave functions of the Wannier type. The model corresponds to the empty-core plane-wave model of Ashcroft. The properties investigated were the cohesive energy, lattice parameter, compressibility, P-V relation, and energy of an electron at the bottom of the conduction band. The results are in satisfactory agreement with experiment and show that a localized-electron theory can be used in a practical way to describe cohesion in metals. A comparison of our calculation to other recent treatments of cohesion is also given. (auth)

13217 VACUUM-ULTRAVIOLET OPTICAL PROPERTIES OF SINGLE-CRYSTAL CADMIUM. Olson, C.G.; Lynch, D.W. (Ames Laboratory, United States Atomic Energy Commission and Department of Physics, Iowa State University, Ames, Iowa 50010). Phys. Rev. B 9: No. 8, 3159-3168 (15 Apr 1974).

The reflectivity of single-crystal Cd has been measured between 350 and 2500 Å using synchrotron radiation. The data have been Kramers-Kronig analyzed and corrections for an overlayer of CdO discussed. The imaginary part of the dielectric constant exhibits a sharp rise at about 9.35 eV due to the onset of transitions from the top of the 4d bands to the Fermi level. These transitions persist, with structure, to high energy, only about a third of their oscillator strength being used by 30 eV. The bulk and surface plasmon energies are found to be 8.80 and 7.30 eV. (auth)

13218 SPIN-ORBIT ENERGY GAP IN CADMIUM. Douglas, R.J.; Datars, W.R. (Department of Physics, McMaster University, Hamilton, Canada). Phys. Rev. B 9: No. 8, 3619-3621 (15 Apr 1974).

A determination of the spin-orbit energy gap in cadmium is reported from a fit of calculated induced torque to measurements of induced torque showing magnetic breakdown. The energy gap is 0.023 eV assuming the Fermi velocity to be the free-electron Fermi velocity. (auth)

13219 EFFECT OF CARBON ON THE HEAT RESISTANCE, PHASE COMPOSITION, AND MECHANICAL PROPERTIES OF STEEL Kh13S2YU2BT. Ryabchenkov, A. V.; Maksimov, A. I.; Bekętov, B. I.; Gordeeva, A. K. (Central Scientific-Research Inst. of the Tech. of Machine Construction, Moscow). Prot. Metals (USSR) (Engl. Transl.); 9: No. 2, 163-165(1973).

Translated from Zashch. Metal.; 9: No. 2, 179-181(1973).

The effects of 0.03 to 0.30% C on steel Kh13S2Yu2BT (2% Al, 1.6% Si, 14% Cr, 0.5% Mn, 0.4% Ti, 1.1% Nb) were investigated. Results show that the oxidation rate increases with the C content. The phase composition affects the character of oxidation; intensive pitting is observed during high-temperature oxidation from the time carbides of the $(Fe, Cr)_7C_3$ appear. (DLC)

13220 FEATURES OF THERMAL STRUCTURE STABILITY OF INTERNALLY OXIDIZED NICKEL ALLOYS. Alen'kin, V. I.; Kulikov, V. A.; Shurygin, A. N. (Tomsk State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 1, 85-92(1974). (In Russian).

The heat strength of dispersion-strengthened alloys is mainly determined by the structure stability at high temperatures, particle size, and homogeneity of distribution in the metal matrix. Binary alloys on a nickel base with additions of Al, Nb, Nd, and Sc (0.2 at.%) were melted in an induction furnace with an inert atmosphere, and foils 0.1 mm thick were prepared by vacuum rolling. The samples were subjected to internal oxidation and were annealed in evacuated quartz ampules at 1000, 1100, and 1170°C from 10 to 100 h. The annealed foils were electropolished and replicas examined in an electron microscope. The structure was found to be coarsened in all the samples: the average particle size increases, and the number of particles per unit volume decreases. The structure coarsening is a maximum at small distances from the sample surface and is significantly less at large depths. The volume fraction of oxide phase decreases at the highest annealing temperatures and at small depths. This feature of the structure coarsening of internally oxidized alloys is explained by the particular distribution of oxide phase along the alloy depth. With increasing distance from the sample surface, the average particle size and the distance between the particles increase. As a result of this behavior, the concentration of oxide elements in solution, because of the difference in oxide particle sizes, decreases with depth. Thus there is a different rate of coagulation at various distances from the sample surface. The study showed a very low thermal structure stability in the internally oxidized alloy Ni-Nb and a higher thermal structure stability in the Ni-Al, Ni-Sc, and Ni-Nd systems, corresponding with previous thermodynamic estimates. (SJR)

13221 INVESTIGATION OF THE INTERACTION OF OXYGEN WITH THE (111) FACE OF A TUNGSTEN SINGLE CRYSTAL BY THE FLASH METHOD. Vas'ko, N.P.; Ptushinskii, Y.G.; Mitryaev, A.A. (Institute of Physics, Academy of Sciences of the Ukrainian SSR, Kiev). Sov. Phys.-Solid State 15: No. 10, 1942-1944 (15 Apr 1974).

A pulse time-of-flight mass-spectrometer investigation showed that oxygen adsorbed at low frequencies on the (111) face of tungsten was flash-desorbed in the form of molecules of the oxides WO_3, WO_2, and WO and in the form of oxygen atoms. The oxides were desorbed before the saturation of the atomic oxygen phase. In contrast to the (100) and (110) faces of tungsten, the dependence of the amount of desorbed atomic oxygen on temperature of the substrate during adsorption had a maximum at 1200°K, corresponding to an atom density of $6.5.10^{14}$ cm^{-2}. This was attributed to the formation of (110) facets on the (111) face, which increased the number of adsorption centers and roughened the (111) face. The oxygen atoms were desorbed by a first-order reaction and the adsorbed oxygen atoms were entirely responsible for the desorbed atomic phase. The activation energy of the desorption of the oxygen atom at 2400°K was 6.2 eV (on the assumption that the preexponential factor in the desorption rate equation was kT/h). (auth)

13222 PROPERTIES OF LIQUID SODIUM AT HIGH TEMPERATURES. Shin, H. J. Gainesville, FL; University of Florida (1973). 107p. University Microfilms Order No. 74-9564. Thesis (Ph. D.).

A method for computing the radial distribution function of the nuclei and electrons in a fluid was further developed and tested on sodium at high temperatures at the density of liquid sodium just above its melting point. This procedure gives essentially exact results in the limit of infinite temperatures but encounters increasing difficulty as the temperature is lowered. The calculations were made with very crude approximations to uncover the difficulties that may be encountered in the more time-consuming procedures now under development using Monte Carlo techniques. Despite the rough approximations, it is quite possible that the radial distribution functions obtained are superior to the Debye-Hueckel-Thomas-Fermi calculations of Kirkwood and Cowan at high temperatures. Advantage is taken of techniques currently available for calculating the radial distribution functions of classical liquids. The Slater sum is written in the form of a classical Boltzmann factor with an effective potential. This effective potential is approximated as a sum over all pairs of effective pair potentials between particles. A differential equation is used to compute these effective potentials. It was previ-

ously derived by differentiating the Slater sum with respect to the temperature. The accuracy of two additional approximations was investigated. One arises from the sum over wave functions that remains in the differential equation after as many of the terms of the effective pair potentials. This sum was evaluated with the aid of the Thomas–Fermi approximation and found to be small. Finally, different techniques for separating the many-body differential equation into equations involving the coordinates of only one pair of particles have been tested. Comparisons for the nuclear-electron pair distributions with those obtained by the Thomas–Fermi and Hartree–Fock approximations were made, and one of the separation techniques was found to be promising and definitely superior to the others. The effective potentials also allowed the testing of Monte Carlo and integral equation methods for computing the radial distributions between nuclei and electrons. (Diss. Abstr. Int., B)

13223 FLOW AND FRACTURE OF TYPE 304 AUSTENITIC STAINLESS STEEL BAR AND WELDMENTS. Dalder, E. N. C. Columbus, OH; Ohio State Univ. (1973). 232p. University Microfilms Order No. 74-10,939.

Thesis (Ph. D.).

Type 304 austenitic stainless steel bar and welded plate, the former in the solution–annealed and sensitized conditions, the latter in the as-welded condition, were evaluated for propensity towards localization of plastic flow in torsion. Testing was conducted over the temperature: strain-rate envelope 75-1200°F: 0.07 to 4.8 per minute. Results indicate that fracture initiation in all cases was associated with the formation of voids at second-phase:austenite interfaces. Fracture propagation in the majority of cases involved macroscopic localization of plastic flow on planes of maximum shear strain and subsequent separation on one of these planes. Fracture propagation in the few cases that did not involve macroscopic localization of plastic flow involved coalescence of voids by microscopically thin localization of plastic flow between voids. In all cases, fracture propagation required continued plastic straining, indicating that fracture occurred by the stable mode. Dynamic strain aging in both conditions of bar was seen and possible causes discussed. Possible interactions between radiation-induced defects and mechanical straining were also considered. Application of the results to design of the LMFBR was undertaken, and it was concluded that any ductility limitations to the use of this material in LMFBR applications would be confined to the weldments. (Diss. Abstr. Int., B)

13224 STUDY OF SNOEK PINNING OF DISLOCATIONS IN HIGH PURITY NIOBIUM. Quist, O. P. Denver, CO; Univ. of Denver (1973). 108p. University Microfilms Order No. 74-8430.

Thesis (Ph. D.).

The dislocation–interstitial interactions in two purity grades of high-purity niobium rods were studied by measuring the dislocation damping as a function of time, temperature, strain, amplitude, and applied stress. Data were obtained using a composite Marx oscillator with a resonant frequency of 50 kHz. Both grades of material exhibited a decrease in dislocation damping in the 0-60°C temperature range. The observed damping decrease is attributed to the pinning of dislocations by Snoek ordering of oxygen interstitial atoms in the strain field of the dislocation line segments. An expression was developed of the form $\delta(t,T) - \delta_0 = (\delta_M - \delta_0) \exp[-(t/\tau_0)^{\alpha}] \exp-(Q/3RT)]$ which relates the dislocation damping behavior to the time and temperature dependence of the Snoek ordering, where $\delta(t,T)$ is the dislocation damping, δ_0 and δ_M are the values of the damping at large and zero times respectively, t is the time, τ_0 is a constant, Q is the activation energy for the diffusional process, and RT has its usual meaning. The relation was shown to be consistent with the obtained data. (Diss. Abstr. Int., B)

13225 MICROWAVE ABSORPTION IN GADOLINIUM–YTTRIUM ALLOYS. Mojumder, M. A. Notre Dame, IN; Univ. of Notre Dame (1974). 148p. University Microfilms Order No. 74-8896.

Thesis (Ph. D.).

The magnetoelastic excitation spectra as a function of an external field were derived for the cases of helicoidal and fan structures by including the magnetoelastic terms. The numerical values of the excitation frequencies are obtained by calculating the eigenvalues of two 14 × 14 matrices using the Q-R Algorithm. Experimental investigation of the microwave absorption spectra of two Gd–Y alloys has been done from liquid helium to room temperatures, using microwave radiation of frequency ranging from 9 to 37 GHz, and magnetic field varying from 0 to 19 kOe. Gd–Y alloys are convenient analogs of the heavy rare earths, and results of experimental investigation agree reasonably well with the calculations. (Diss. Abstr. Int., B)

13226 NEW ELECTRONIC INTERACTIONS IN RARE-EARTH METALS AT HIGH PRESSURE. Gust, W. H.; Royce, E. B. (Univ. of California, Livermore). Phys. Rev., B; 8: No. 8, 3595-3609 (15 Oct 1973).

Equation-of-state data have been obtained from shock-wave experiments on Sc, Y, La, Ce, Pr, Nd, Sm, Eu, Gd, Dy, Yb, and Hf. It is deduced that only Ce exhibits phenomena that may be related to a $4f \rightarrow 5d$ electronic phase transition. An abrupt decrease in compressibility at high pressure is taken to be evidence of the onset of interaction between closed electron shells in metals. This work is the first identification of the closed-shell electronic interactions in metals in a high-pressure experiment. (auth)

13227 NOVEL MORPHOLOGY OF Pb/Sn/Cd/Zn QUATERNARY EUTECTIC. Fisher, D. J.; Kurz, W. (Ecole Polytechnique, Lausanne, Switzerland). Met. Trans.; 5: No. 6, 1508-1510(Jun 1974).

Structures in a directionally solidified four-phase eutectic composed of these elements were examined. Microprobe examination and the use of the selective etchants established that the structure consisted of a tin rich matrix (white) containing (Cd) lamellae (pale grey) each sandwiched between (Pb) lamellae (dark grey) (the Pn/Sn/Cd structure), plus (Zn) lamellae generally perpendicular to the other phases. (JRD)

13228 MEASUREMENT OF THE ENTHALPIES OF FORMATION OF $ZrPt_3$ AND $HfPt_3$ BY FLUORINE BOMB CALORIMETRY. Srikrishnan, V.; Ficalora, P. J. (Syracuse Univ., NY). Met. Trans.; 5: No. 6, 1471-1475(Jun 1974).

The enthalpies of formation of $ZrPt_3$ and $HfPt_3$ were determined by fluorine combustion calorimetry. The results (ΔH°_{298} ($ZrPt_3$) = −30.5 ± 2.0 kcal/g atom and ΔH°_{298} ($HfPt_3$) = −33.0 ± 2.5 kcal/g atom) support the predictions of the Engel Brewer Correlation of metals. The unusually large heats of formation are considered to be caused by a transfer of d electrons in a typical Lewis acid-base reaction. (auth)

13229 EFFECT OF SAMPLE SIZE ON THE STEADY STATE CREEP CHARACTERISTICS OF Ni–6% W. Matlock, D. K.; Nix, W. D. (Stanford Univ., CA). Met. Trans.; 5: No. 6, 1401-1412 (Jun 1974).

The effects of sample size and grain morphology on the steady state creep properties of Ni–6% W in the temperature range of 0.55 T_m to 0.74 T_m have been studied. It is shown that a decrease in sample thickness results in a corresponding decrease in the number of grains per thickness and gives rise to a decrease in the measured values of both Q_{creep} and n when compared with existing data on thick samples with many grains per thickness. The observed effects of sample configuration on the creep properties are explained using a model for creep deformation which is based on the interaction of free surfaces with grain boundary sliding and grain deformation. Using this model, an expression for the stress and temperature dependence of the total steady state strain rate is obtained as a function of the grain matrix strain rate and the grain boundary sliding strain rate. The results of application of the model are shown to correlate well with the observed deformation characteristics of the thin samples and to explain the variations of Q_{creep} and n with sample morphology. (auth)

13230 CORRELATION BETWEEN PRECIPITATION REACTIONS AND BULK DENSITY CHANGES IN TYPE 18-12 AUSTENITIC STAINLESS STEELS. Spitznagel, J. A.; Stickler, R. (Westinghouse Research Lab., Pittsburgh). Met. Trans.; 5: No. 6, 1363-1371(Jun 1974).

Dimensional changes in austenitic stainless steels exposed to fast neutron fluxes have been attributed mainly to void formation and thermal and irradiation induced creep. Immersion bulk density measurements were performed on variously preheated AISI Types 304, 316L, and 316 stainless steels. The results show that the density changes accompanying sequential precipitation of the various carbide ($M_{23}C_6$, M_6C) and intermetallic phases (sigma, chi, eta) during thermal aging can be comparable to those attributed to void formation at low fast neutron fluences. Vacuum melted Type 316 stainless steel always densified with aging at 725 or 810°C and exhibited higher rates of precipitation and recovery of cold work during aging than the equivalent air melted steel. The direction of the density change in the air melted material was dependent upon the prior thermomechanical treatments. This behavior can be rationalized on the basis of a higher impurity content in the air melted material. A mathematical model was constructed which successfully explains the variation of bulk density due to sequential precipitation in Type 18-12 austenitic stainless steels. (auth)

13231 THERMODYNAMIC PROPERTIES OF α Cu–In ALLOYS BY THE METHOD OF ATOMIC ABSORPTION. Bhattacharya,

D.; Masson, D. B. (Washington State Univ., Pullman). Met. Trans.; 5: No. 6, 1357-1361(Jun 1974).

Atomic absorption spectroscopy was used to measure the vapor pressure of indium over seven binary alloys of the α Cu–In system. Thermodynamic activity, partial molar enthalpy, and partial molar entropy of indium were calculated from the vapor pressure and its temperature coefficient. The activity coefficient obtained has a large value for alloys of this type, even when referred to a solid reference state. The partial molar enthalpy values are lower than expected for a trivalent solute. The excess partial molar free energy, when plotted against atom fraction, shows a minimum at about 7 at. % indium. The reason for the occurrence of a minimum in $\overline{\Delta G}_{In}^{xs}$ is not known. (auth)

13232 SIMPLE RELATIONSHIP BETWEEN THE TEMPERATURE DEPENDENCE OF THE DENSITY OF LIQUID METALS AND THEIR BOILING TEMPERATURES. Steinberg, D. J. (Univ. of California, Livermore). Met. Trans.; 5: No. 6, 1341-1343 (Jun 1974).

For elemental metals, other than those in Groups VIII and IIB, there exists a simple relationship between the temperature dependence of the liquid density, $\Lambda \equiv (\partial D/\partial T)_P$, and the boiling temperature, T_B. It is shown that the fractional change in density between 0°K and T_B appears to be constant; i.e., $\Lambda T_B/D_{00} = -0.23$. D_{00} is a scale factor defined by $D_{00} = D_M - \Lambda T_M$, where D_M is the density of the liquid at the absolute melting temperature, T_M. This relationship has been used to estimate Λ for eight high melting point elements for which no experimental data exist. (auth)

13233 SOLID SOLUTION SOFTENING AND STRAIN-RATE SENSITIVITY OF Fe–Re AND Fe–Mo ALLOYS. Leemans, D. (Univ. of British Columbia, Vancouver); Fine, M. E. Met. Trans.; 5: No. 6, 1331-1336(Jun 1974).

The resolved shear stress and strain-rate sensitivity of Fe–Mo and Fe–Re alloys, well within the solid solution range, were measured versus temperature and compared with previous results for Fe–Ti alloys. The strain-rate sensitivity-temperature curves shifted systematically to lower temperatures as solute was added. The resolved shear stress was divided into two parts, a dynamic part which is a function of strain-rate and a static part which is not. The strain-rate sensitivity data were inverted to give the dynamic part of the flow stress and this was subtracted from the resolved shear stress to give the static part of the flow stress. Significant solid solution softening occurred in the dynamic part of the flow stress at 166 and 196°K. This is due to intrinsic effects and not to scavenging of impurities. The static part of the flow stress is made up of two parts, a peaking effect superimposed on normal solid solution hardening. (auth)

13234 CORRELATION OF MAGNETIC AND MECHANICAL PROPERTIES WITH MICROSTRUCTURE IN Fe/Co/2-3% V ALLOYS. Pinnel, M. R.; Bennett, J. E. (Bell Telephone Labs., Columbus, OH). Met. Trans.; 5: No. 6, 1273-1283(Jun 1974).

Remendur is an alloy of approximately equal proportions of iron and cobalt with two to four wt. % vanadium. In previous articles, various aspects of the ternary phase equilibrium and the influence of processing variations on microstructure were described. A more complete correlation among microstructure, mechanical properties, magnetic properties, and resistivity is reported. For strand annealed (900 to 950°C) material, the mechanical properties are only a weak function of annealing temperature but a strong function of vanadium content. Subsequent annealing at 600°C significantly increases the yield and tensile strengths but the mode of fracture becomes brittle cleavage, in contrast to the ductile failure of strand annealed material. Coercivity in the strand annealed (900 to 950°C) and quenched condition is primarily determined by grain size and transformation strains produced during the quench. Coercivity in 600°C annealed material is due to the fine dispersion of stable γ particles in the α_1' matrix which are impediments to domain wall motion. In general, resistivity is relatively independent of processing temperature. (auth)

13235 INFLUENCE OF HEAT TREATMENTS ON MICROSTRUCTURES IN AN Fe–Co–V ALLOY. Mahajan, S. (Bell Telephone Labs., Inc., Murray Hills, NJ); Pinnel, M. R.; Bennett, J. E. Met. Trans.; 5: No. 6, 1263-1272(Jun 1974).

The microstructural changes in an Fe–Co–V alloy (composition by wt. %: 2.97 V, 48.70 Co, 47.34 Fe and balance impurities, such as C, P, and Ni) resulting from different heat treatments have been evaluated by optical metallography and transmission electron microscopy. Results indicate that, on air cooling or quenching into iced-brine from the high temperature single-phase γ (fcc) field, vanadium can be retained in a supersaturated solid solution (α_2) which has bcc structure. For the range of cooling rates employed, a portion of the material appears to undergo the γ-α_2 transformation massively and the remainder martensitically. Also antiphase boundaries are observed in the air-cooled samples. On annealing in the two-phase $\alpha_1 + \gamma$ field, α_2 decomposes into vanadium-rich subgrains (γ) and vanadium-poor subgrains (α_1), and only the former undergo the $\gamma \rightarrow \alpha_1$ transformation during air cooling or iced-brine quenching. The α_1 subgrains in a sample, slowly quenched in quartz, show superlattice dislocations and antiphase boundaries, whereas both the transformed and untransformed areas exhibit ⟨100⟩ superlattice reflections. There is, however, no evidence of long-range order in the specimens quenched into iced-brine. The two-phase annealing sequence followed by a 2 h anneal at 600°C and air cooling results in precipitation within the vanadium-rich, transformed subgrains. Also there is evidence of long-range order in both types of subgrains. (auth)

13236 EXPERIMENTAL STUDY OF THE FERMI SURFACE OF VANADIUM. Parker, R.D.; Halloran, M.H. (Departments of Physics and Electrical Engineering, The University of Southern California, Los Angeles, California 90007). Phys. Rev. B 9: No. 10, 4130-4137 (15 May 1974).

The Fermi surface of vanadium has been studied experimentally using magnetothermal-oscillation techniques in the {100} and {110} planes in fields of 7–11 T. The Fermi surface has qualitatively the same topology as those of tantalum and niobium: a set of six distorted ellipsoidal surfaces centered at N in the Brillioun zone, and a multiply connected jungle-gym surface consisting of interconnecting arms along the ⟨100⟩ directions with intersections at Γ and H. The data, taken on samples supplied by the U.S. Bureau of Mines, are qualitatively consistent with recent argumented-plane-wave (APW) calculations, and agree excellently with previous experimental data. The observed extremal areas near the symmetry directions are: ⟨100⟩, 33.1 nm^{-2} attributed to the jungle-gym necks, 50.5 and 57.6 nm^{-2} attributed to the ellipsoids; at ⟨111⟩, 47.9 nm^{-2} attributed to the ellipsoids; at ⟨110⟩, 64.1, 50.4, and 53.1 nm^{-2} attributed to the ellipsoids. Effective masses, measured using the de Haas-van Alphen effect, ranged from 1.7 to 2.2 times the free-electron mass for the ellipsoids, while the orbit around the jungle-gym arms at ⟨100⟩ was found to have an effective mass of 3.0. The data are consistent with the existence of necks along the Γ–N direction, connecting the ellipsoids to the jungle gym. (auth)

13237 ELECTRIC FIELD GRADIENTS IN COPPER-NICKEL ALLOYS. Whalley, L.R.; Slichter, C.P. (Department of Physics and Materials Research Laboratory, University of Illinois, Urbana, Illinois 61801). Phys. Rev. B 9: No. 9, 3793-3796 (1 May 1974).

We have measured the electric field gradients at copper atoms which are near neighbors to the nickel impurity in a dilute CuNi alloy. The technique used in this study is zero-field pure quadrupole resonance which was first demonstrated by Redfield. The measured electric field gradients for this alloys system are 4.1×10^{23} cm^{-3}, 0.84×10^{23} cm^{-3}, 0.46×10^{23} cm^{-3}, and 0.146×10^{23} cm^{-3}. These measured values are compared to the values calculated by Beal-Monod. In addition, the following alloy systems are studied: CuCo, CuFe, and CuV. The nuclear relaxations of these alloys were measured but no satellite structure was detected. (auth)

13238 TEMPERATURE DEPENDENCE OF THE MAGNETIC EXCITATIONS IN SINGLET-GROUND-STATE SYSTEMS: PARAMAGNETIC AND ZERO-TEMPERATURE BEHAVIOR OF Pr_3Tl AND $(Pr, La)_3Tl$. Holden, T.M.; Buyers, W.J.L. (Atomic Energy of Canada Limited, Chalk River, Ontario, Canada). Phys. Rev. B 9: No. 9, 3797-3805 (1 May 1974).

Neutron scattering experiments have shown that the magnetic excitations in polycrystalline $(Pr, La)_3Tl$ compounds are only weakly temperature dependent. This contrasts with the strong temperature renormalization predicted by the simple singlet-singlet and singlet-triplet models of induced moment systems. Calculations have been made of the spin-wave dispersion relation at zero temperature using the pseudoboson model and as a function of temperature in the paramagnetic phase using a generalized susceptibility theory including transitions between all levels of the ground multiplet. As the temperature increases it is found that mode-mode interaction between excitations out of the ground state and those out of excited states plays an important role. The temperature dependence of the excitations is found to be weak for most wave vectors and in agreement with experiment. Near the zone center where no experiments were possible the excitations are more strongly temperature dependent. (auth)

13239 TEMPERATURE DEPENDENCE OF HYPERFINE INTERACTIONS IN Dy–Gd ALLOYS. Sweger, D.M.; Segnan, R. (American University, Washington, D.C. 20016); Rhyne, J.J. Phys. Rev. B 9: No. 9, 3864-3870 (1 May 1974).

The magnetic hyperfine field and quadrupole interaction have been measured in pure dysprosium and three gadolinium–dysprosium alloys using the Mössbauer effect on the dysprosium nucleus. The temperature dependences of H_{hf} and V_{zz} were determined from 4 K up to the ordering temperatures and compared to theory. The hyperfine field obeyed a conventional spin-wave analysis with an anisotropy gap of order 20 K. The quadrupole interaction was found to have the same temperature dependence as predicted theoretically for the single-ion anisotropy. No systematic variation in the low temperature values of H_{hf} or V_{zz} was observed with concentration. (auth)

13240 CHEMICALLY INDUCED CHANGE IN NUCLEAR DECAY RATE AS A TOOL FOR CALIBRATING Fe^{57} ISOMER SHIFTS. Verma, R.N.; Emery, G.T. (Physics Department, Indiana University, Bloomington, Indiana 47401). Phys. Rev. B 9: No. 9, 3666-3669 (1 May 1974).

The calibration constant of Fe^{57} has been determined to be $\delta R/R = -(2.3_{-0.8}{}^{+2.6}) \times 10^{-4}$, from the isomeric chemical shift of the 14.4-keV γ rays, resulting from decay of Co^{57} diffused into zinc and vanadium host lattices. The difference in electron density at the nucleus was obtained directly from the measured difference in decay constant of the isomeric level. The fractional difference in the decay constant of the Mössbauer level of Fe^{57} between zinc and vanadium was measured to be $(4.2 \pm 2.2) \times 10^{-4}$. (auth)

13241 ANOMALOUS ELECTRICAL RESISTIVITY, BCC PHASE STABILITY, AND SUPERCONDUCTIVITY IN TITANIUM-VANADIUM ALLOYS. Collings, E.W. (Metal Science Group, Battelle, Columbus Laboratories, Columbus, Ohio 43201). Phys. Rev. B 9: No. 10, 3989-3999 (15 May 1974).

Precise measurements of the electrical resistivities ρ of a series of Ti-V alloys have been made in the 77-300-K temperature range. The isothermal composition dependences are shown to be anomalously large (by an amount ρ_{anom}) over a concentration range of from about 12-at.% to at least 70-at.% V. Throughout this range $\rho_{anom,77}$ is larger than $\rho_{anom,300}$. Furthermore, within the composition range of 20-33-at.% V, $(\rho_{77} - \rho_{300})_{anom}$ exceeds the decrease in ideal resistivity between 300 and 77 K, leading to a net negative temperature coefficient of resistivity for those alloys. The results are discussed in the context of transition-metal binary-alloy phase stability, expressed in terms of soft phonons which become more and more localized as the solute concentration increases in the average electron-per-atom ratio range 4.1 to 5.0. A connection is made with superconductivity in alloys formed between groups-IV and -V transition metals. It is pointed out that the phonons of instability, which are responsible for the anomalous resistivity, also favor superconductive coupling and consequently a relatively "high" T_c; but that at the same time, this effect must compete with a proximity-effect-induced lowering of the average T_c by the product of the lattice instability (viz., ω phase), which itself has a very low T_c. (auth)

13242 STRENGTHS AND FAILURE MECHANISMS OF A Co-15Cr-13TaC DIRECTIONALLY SOLIDIFIED EUTECTIC ALLOY. Buchanan, E. R.; Tarshis, L. A. (General Electric Corp., Schenectady, NY). Met. Trans.; 5: No. 6, 1413-1422(Jun 1974).

The tensile and stress rupture properties of a Co(Cr)-TaC directionally solidified eutectic alloy have been investigated and compared to those of a single phase, directionally solidified Co(Cr) alloy corresponding in composition to that of the eutectic matrix. The temperature for 100 h stress rupture life at 20,000 psi is about 200°F better than that of any cast nickel-base superalloy now used in aircraft or land gas turbines. The degree of superiority becomes progressively less at higher stresses, and at 50,000 psi, the temperature for 100 h stress rupture life in the eutectic is about 150°F less than for several high strength superalloys. This behavior is related to a bimodal stress rupture mechanism. A model predicts that at low stresses, failure is controlled by the stress rupture behavior of the matrix; and at high stresses failure occurs by a stress relaxation mechanism which causes early fiber failure. Fractographic observations are in agreement with the existence of two stress rupture mechanisms. It was also observed that both stress rupture mechanisms can occur at the same temperature, with specimens failing by the fiber-related mode having lives 1 to 2 orders of magnitude in time less than those which fail by the matrix-related mode at the same stress level. (auth)

13243 PREDICTION OF K_{Ic} FROM TENSILE DATA. Baskes, M. I. (Univ. of California, Livermore). Eng. Fracture Mech.; 6: No. 1, 11-18(Mar 1974).

A theory of fracture toughness is developed which is based on the Dugdale crack model (J. Mech. Phys. Solids; 8: 100-4 (1960)). Work hardening is considered. By using the stress-strain curves as input data, K_{Ic} values are predicted for a wide range of materials including U alloys, Be, Al, a Ni-Co alloy, and a Ti alloy. The calculated values agree exceptionally well with the experimental values. Plastic-zone size (including a qualitative estimate of shape) and stress and strain in the plastic zone are also predicted. (auth)

13244 TEMPERATURE DEPENDENCE OF THE NUCLEAR SPIN RELAXATION RATE OF LIQUID ^{115}In. Halder, N. C. (Univ. of South Florida, Tampa). Phys. Status Solidi (b); 63: No. 1, 397-402(1 May 1974).

Temperature dependence of the atomic structure and self diffusion coefficient have been considered to predict the temperature dependence of the nuclear magnetic relaxation rate W_{1m} and the nuclear quadrupolar relaxation rate W_{1q}. Results of the calculation indicate that a substantial amount of the relaxation rate comes from the nuclear quadrupolar interaction. While W_{1m} increased from 3.677 to 6.894 ms^{-1}, W_{1q} decreased from 0.276 to 0.070 ms^{-1} in the temperature range 170 to 650°C. (auth)

13245 EFFECTS OF PRESSURE ON THE ELECTRONIC STRUCTURE OF TRANSITION D-METALS. Svechkarev, I. V.; Panfilov, A. S. (Physico-Technical Inst. of Low Temperatures, Kharkov). Phys. Status Solidi (b); 63: No. 1, 11-50(1 May 1974).

A review of atomic volume change effects on the properties of transition elements is presented. Information is included on electronic spectral parameters, effects of crystal potential defects, effects of interatomic separation, spectral pressure dependence, electron state densities, and effects of pressure on energy levels. (JRD)

13246 EVIDENCE FROM TRANSPORT MEASUREMENTS AT HIGH PRESSURES FOR DONOR IONS OCCUPYING NON-EQUIVALENT LATTICE POSITIONS IN InSb. Porowoski, S.; Konczykowski, Chroboczek, J. (Inst. of Physics, Warsaw). Phys. Status Solidi (b); 63: No. 1, 291-296(1 May 1974).

Measurements of the Hall coefficient in undoped, extrinsic n-type InSb were made as a function of temperature at hydrostatic pressures of several kbar. The results give evidence of the existence of donor states associated with ions which can occupy two non-equivalent positions in the lattice. (auth)

13247 DETECTION OF TRANSVERSE SINGLE AND SEQUENTIAL VOLTAGE PULSES AXIALLY INDUCED BY A LASER IN A THIN MOLYBDENUM FILM. Vezzoli, G.C. (Engineering Science Division, Electro-Optics Section, Feltman Research Laboratory, Picatinny Arsenal, Dover, New Jersey 07801); Walsh, P.J.; Kisatsky, P. J. Appl. Phys. 45: No. 7, 2987-2990 (July 1974).

A short pulse (50-100 nsec) of laser light incident in the z direction causes sequential voltage pulses of opposite polarity in the xy plane of a thin molybdenum film deposited on a polycrystalline aluminum oxide substrate. A laser pulse incident in the z direction to a molybdenum thin film deposited on a transparent glass substrate generates a single voltage pulse in the xy plane whose polarity reverses when the laser beam is introduced from the -z direction. The pulses are interpreted as consequences of a forward and reverse thermal gradient in an anisotropic film, and the data can be quantitatively described using the heat-diffusion equation. (auth)

13248 RELATIONSHIP OF MECHANICAL CHARACTERISTICS AND MICROSTRUCTURAL FEATURES TO THE TIME-DEPENDENT EDGE-NOTCH SENSITIVITY OF INCONEL 718 SHEET. Wilson, D. J. ASME Publication No. 73-Mat-G. New York; American Society of Mechanical Engineers (1973). 12p.

Time-dependent notch sensitivity of Inconel 718 sheet was observed at 900 to 1200°F. It occurred when edge-notched specimens were loaded below the yield strength and smooth specimen tests showed that small amounts of creep consumed large rupture life fractions. The severity of the notch sensitivity was reduced by decreasing the temperature of the solution treatments, increasing the time and/or temperature of ageing and increasing the test temperature to 1400°F. Elimination of time-dependent notch sensitivity correlated with a change in dislocation motion mechanism from shearing to by-passing precipitate particles. (Metals Abstr.)

13249 NIOBIUM-HYDROGEN SYSTEM AND HYDROGEN EMBRITTLEMENT OF NIOBIUM. Huntsville, AL; Marshall Space Flight Center (1970). 100p.

Methods were developed to charge Nb specimens uniformly with H and to accurately measure the H concentration. The Nb-H phase diagram was determined with two different Nb purity levels. The phase diagram included a miscibility gap and an eutectoid transformation. A peritectoid transformation is postulated at the H-rich end of the diagram. The effect of H content on the ductile-to-transition temperature as determined for temperatures between 200 and 600°F. Brittle fracture occurred at 700 and 800°F for specimens containing very large H additions. The strength and ductility of Nb was found to be essentially independent of H content. (Metals Abstr.)

13250 CRYSTAL STRUCTURE OF $Nb_{12}Al_3Ge$. Ageev, N. V.; Alekseevskii, N. E.; Shamrai, V. F. pp 99-103 of Khimiya Metal. Splavov. Moscow; Izdatel'stvo Nauka (1973). (In Russian).

Studies were made of the ordering of the crystal structure and substructure of the compound $Nb_{12}Al_3Ge$ after various heat treatments and after mechanical testing; the effect on the superconducting transition temperature was also studied. Symmetry changes in crystals of O^3 type that occur after II-order phase transformations are examined, and possible causes are considered for the increase that occurs in the value of the above temperature when alloying additions are made to $Nb_{12}Al_3Ge$. (Referativnyi Zh.)

Radiation Effects

Refer also to abstracts 12531-12533, 12535, and 13088.

13251 (RISO-M-1706) COMPUTER SIMULATION OF THE LOW TEMPERATURE NEUTRON IRRADIATION, HIGH TEMPERATURE ANNEALING MODE OF VOID FORMATION IN MOLYBDENUM. Evans, J. H. (Danish Atomic Energy Commission, Risoe. Research Establishment). Apr 1974. 19p. Dep. NTIS (US Sales Only $4.00.

Results appear to confirm that the model of void formation previously proposed could lead to the experimentally determined high efficiency of vacancy retention and give swelling rates one or two orders greater than that possible in high-temperature void formation. Some of the important parameters are identified and discussed. There appeared to be no reason why the irradiation/annealing mode of void formation should not apply to metals other than molybdenum. (auth)

13252 (RISO-M-1712) SWELLING RESISTANCE INDUCED BY GRAIN REFINEMENT AND PARTICLE DISPERSION IN AUSTENITIC STAINLESS STEEL DURING HIGH ENERGY ELECTRON IRRADIATION. Singh, B. N. (Danish Atomic Energy Commission, Risoe. Research Establishment). Apr 1974. 20p. Dep. NTIS (US Sales Only) $4.00.

Thin-foils of an austenitic stainless steel with and without dispersions of aluminum oxide particles are irradiated in a high-voltage electron microscope at 600°C; prior to irradiation, up to 1000 ppM of helium atoms are implanted in the thin foils. The void concentration and the swelling decreased with decreasing size of the grains irradiated; the effect of grain size being more marked in the dispersed specimens. The grain size effect persisted also in specimens containing high concentrations of helium. The influence of high concentrations of helium on void growth and swelling is investigated. The dose dependencies of void size and swelling for grains of different sizes and with different helium concentrations are described. Results are analyzed in terms of grain size-dependent vacancy supersaturation and are found to be consistent with the "defect depletion" model recently proposed by the author. It is concluded that void nucleation is critically dependent on vacancy supersaturation and that the grain size effect is predominantly nucleation controlled. (auth)

13253 CALCULATED GRAIN SIZE-DEPENDENT VACANCY SUPERSATURATION AND ITS EFFECT ON VOID FORMATION. Singh, B. N.; Foreman, A. J. E. (Danish Atomic Energy Commission, Risoe). Phil. Mag.; 29: No. 4, 847-857(Apr 1974).

In order to study the effect of grain size on void formation during high-energy electron irradiations, the steady-state point defect concentration and vacancy supersaturation profiles were calculated for three-dimensional spherical grains up to three microns in size. In the calculations of vacancy supersaturation as a function of grain size, the effects of internal sink density and the dislocation preference for interstitial attraction were included. The computations show that the level of vacancy supersaturation achieved in a grain decreases with decreasing grain size. The grain size dependence of the maximum vacancy supersaturation in the center of the grains is found to be very similar to the grain size dependence of the maximum void number density and void volume swelling measured in the central regions of austenitic stainless steel grains. This agreement reinforces the interpretation that the grain size effect is due primarily to the depletion of point defects from the grain interior. It is suggested that the void nucleation is strongly dependent on the level of vacancy supersaturation. (auth)

13254 WEAK-BEAM ELECTRON MICROSCOPY ANALYSIS OF DEFECT CLUSTERS IN HEAVY-ION IRRADIATED SILVER AND COPPER. Jenkins, M. L. (Oxford Univ.). Phil. Mag.; 29: No. 4, 813-828(Apr 1974).

The weak-beam technique has been used to investigate the geometry of point-defect clusters in silver and in copper produced by heavy-ion bombardment. It was found that many of the clusters could be identified as partially dissociated Frank loops, confirming the interpretation by Wilson and Hirsch (Wilson, M. M. and Hirsch, P. B., 1972, Phil. Mag., 25, 983) of certain black-white contrast features. A model of dissociated loops in (111) foils is proposed which could explain the observed fine structure of the weak-beam images. The detailed geometry of this model arises due to the influence of surface image forces on the loop dissociation. (auth)

13255 EFFECT OF FAST NEUTRON IRRADIATION ON CRITICAL CURRENT DENSITY OF Nb-Ti ALLOY FOR FUSION REACTOR. Tsubakihara, H. (Osaka Univ.); Okada, T.; Suita, T.; Horiuchi, T.; Matsumoto, K. J. Nucl. Sci. Technol. (Tokyo); 11: No. 2, 77-79(Feb 1974).

13256 RADIATION HARDENING AND RECOVERY IN 2Cr-1Mo PRESSURE VESSEL STEEL (ASTM A542). Takahashi, J.; Yamane, T. (Osaka Univ.). J. Nucl. Sci. Technol. (Tokyo); 11: No. 3, 114-115(Mar 1974).

13257 DEPTH PROFILING OF ^{3}He AND ^{2}H IN SOLIDS USING THE ^{3}He(d, p) ^{4}He RESONANCE. Pronko, P.P. (Argonne National Laboratory, Argonne, Illinois 60439); Pronko, J.G. Phys. Rev. B 9: No. 7, 2870-2878 (1 Apr 1974).

An in situ nondestructive probe for measuring the concentration and distribution of helium and hydrogen isotopes in near-surface layers of solids is described. The technique makes use of the ^{3}He(d, p) ^{4}He resonant nuclear reaction. A probing beam of deuterons is used to analyze for ^{3}He (a ^{3}He beam may be used to analyze for deuterium). Stopping-power effects control deceleration of the probing beam and bring the energy into the resonance window. Integration of the proton yield at a given beam energy determines the quantity of ^{3}He or deuterium at the depth associated with the probe upon entering resonance. Spatial resolution of the method is defined by the 350-keV full width at half-maximum for the resonance cross section. Examples of ion-implanted ^{3}He distributions in niobium are presented along with a discussion of mathematical-deconvolution and oblique-incidence resolution-enhancement techniques. Normal-incidence resolution is ~3 μm and can be improved using mathematical deconvolution. Oblique incidence (75° from the normal to the surface) in conjunction with deconvoultion, yields adjacent-peak-position resolution to nominal values of 3000 Å by artificially broadening the distribution of ^{3}He without changing the resolution function. Small-angle multiple scattering and energy straggling of the probing beam under these conditions introduces a limit on peak-width resolution of about 6000 Å. Differential cross sections for the reaction range between 50 and 80 mb/sr (depending on observation angle), which results in minimum observable concentrations of about 10 ppm. The method has technical value for analyzing potential problems associated with the implantation of helium in materials that may be used for the primary containment wall of controlled-fusion reactors. (auth)

13258 EXPERIMENTAL EVIDENCE FOR SPLIT INTERSTITIALS IN COPPER. Holder, J. (Department of Geology and Materials Research Laboratory, University of Illinois, Urbana, Illinois 61801); Granato, A.V.; Rehn, L.E. Phys. Rev. Lett. 32: No. 19, 1054-1057 (13 May 1974).

The magnitudes, anisotropy, and temperature dependences of the three independent elastic constants of copper irradiated below 4 K with thermal neutrons provide evidence for the <100> split configuration of free interstitials and thermally excited resonance modes, and lead to a model for the configuration of the I_C close-pair defect. (auth)

13259 CHARACTERISTIC-ENERGY-LOSS SPECTRA OF VANADIUM AND OF V_2O_3. Szalkowski, F.J. (Science Center, Rockwell International, Thousand Oaks, California 91360); Bertrand, P.A.; Somorjai, G.A. Phys. Rev. B 9: No. 8, 3369-3376 (15 Apr 1974).

The characteristic loss spectra of a vanadium-metal single crystal and of a V_2O_3 powder have been observed in reflection using an incident electron beam in the energy range of 100-700 eV. Assignment of an inelastic-loss mechanism to each of the characterististic-loss peaks is made and these assignments appear to be consistent with all of the observations made on vanadium to date. In certain circumstances, the probability of an incident electron undergoing a multiple-interband-transition energy loss may be greater than the single-loss probability; the realization of this phenomenon is instrumental in providing a complete interpretation of the data. (auth)

13260 CHANNELING AND RELATED EFFECTS IN THE MOTION OF CHARGED PARTICLES THROUGH CRYSTALS. Gemmell, D.S. (Argonne National Laboratory, Argonne, Illinois 60439). Rev. Mod. Phys. 46: No. 1, 129-227 (Jan 1974).

The motion of energetic charged particles inside a monocrystalline solid can be strongly influenced by channeling and blocking effects. The present article reviews the theory, the experimental studies, and some of the applications of these effects. The coverage of the published literature extends through June 1973. (auth)

13261 RELATIVE EFFECTS OF CHROMIUM, MOLYBDENUM, AND TUNGSTEN ON THE OCCURRENCE OF σ PHASE IN Ni-Co-Cr ALLOYS. Kirby, G. N. (Crawford and Russel, Inc., Stanford, CT); Sponseller, D. L.; Van Vlack, L. H. Met. Trans.; 5: No. 6, 1477-1494(Jun 1974).

The relative effects of chromium, molybdenum, and tungsten on the occurrence of σ phase have been studied in Ni-Co-Cr alloys. These alloys were designed to simulate the γ matrix in commercial nickel-base superalloys that are strengthened primarily by precipitation of the γ′ phase, based on Ni_3Al. Three alloy series were studied. The first series comprised four alloys varying in chromium content from 34.63 to 43.65 at.%. The other two series contained separate molybdenum and tungsten additions of 1, 2, 3, and 4, at.% of constant chromium contents of 37.5 at.%. In each of the 12 alloys, the atomic percentages of nickel and cobalt were equal. The alloys were aged in both the annealed and cold-rolled conditions at 1400, 1550, and 1700°F for times up to 3000 h. The contributions of the chromium-group elements to σ formation were evaluated both by measuring the volume percentage of σ phase and by determining the final composition of the γ matrix after σ precipita-

tion. By these two techniques, critical values of the average electron vacancy number, $\bar{N}_v$, for σ formation at 1550°F were found to be 2.518 and 2.512, respectively; σ precipitation was most rapid at 1550°F. Results indicated that under conditions approaching equilibrium, molybdenum and tungsten are equivalent in inducing σ formation and more potent than chromium. The approximate electron vacancy coefficients (N_v) for molybdenum and tungsten, as derived from volume-fraction measurements of σ phase, are as follows: 7.35 at 1400 and 1550°F, and 8.7 at 1700°F. The values derived from final compositions of the γ matrix after σ precipitation are 7.9 at 1550°F and 8.6 at 1700°F. The bulk diffusion of aluminum into alloys that were otherwise not σ-prone at 1700°F caused extensive σ precipitation during aging. This was due to copious precipitation of $\gamma'-Ni_3Al$ and $\beta-NiAl$, resulting in enrichment of the matrix in elements of the chromium group. (auth)

13262 IDENTIFICATION OF $\alpha-Mn$ CRYSTAL STRUCTURE IN NEUTRON IRRADIATED W–Re ALLOY. Sikka, V. K.; Moteff, J. (Univ. of Cincinnati). Met. Trans.; 5: No. 6, 1514-1517(Jun 1974).

Precipitation of $\alpha-Mn(WRe_3)$ crystal structure in neutron irradiated W–25 Re alloy is examined. Results show that neutron irradiations result in the transmutation of some of the W atoms to Re atoms such that the composition of the alloy may exceed the solid solution limit. This circumstance is expected to be small for the neutron gamma reaction in the fast spectrum EBR-II reactor. In such a situation, the σ-phase (WRe) should form. Since no second phases were observed following the higher temperature (1700°C) anneal of the irradiated specimen it is concluded that any transmutation products would be quite small. The results also show that the proposed $\alpha-Mn$ (WRe_3) phase goes into solution at a temperature no greater than 1700°C. An explanation for the irradiation induced formation of $\alpha-Mn$ phase is not available at the present time. It is however quite possible that due to atom size and/or valence differences between Re and W atoms that the atom displacements produced in the collision cascade regions would favor a Re atom rich core which could be nucleation sites for the $\alpha-Mn$ phase. (JRD)

13263 ELECTRON IRRADIATION OF GOLD BELOW 2°K. Gwozdz, P. S.; Koehler, J. S. (Univ. of Illinois, Urbana). Phys. Rev., B; 8: No. 8, 3616-3627(15 Oct 1973).

Gold (99.9999% purity) was irradiated by 2.5-MeV electrons below 2°K. Damage production was monitored by measuring the dc resistivity of the gold. The production rate $d\rho/d\phi$ (change in resistivity per integrated electron flux) was found to (a) be enhanced by the presence of quenched vacancies at extremely low values of integrated flux, (b) be attenuated by the presence of quenched vacancies at higher values of integrated flux, (c) decrease with increasing Φ particularly at the lowest values of Φ, and (d) increase with increasing $d\phi/dt$ (beam flux). Thermal recovery of resistivity was observed as low as 2.3°K. The recovery in the range 2.3 to 30°K was found to (a) be enhanced by the presence of quenched vacancies, (b) be attenuated by the presence of silver impurities, and (c) increase with increasing Φ. These observations are consistent with the hypothesis that the interstitial in gold undergoes long-range migration either during electron irradiation at 1.7°K or during annealing at 1.95°K. (auth)

13264 DISLOCATION LOOP IN AN ANISOTROPIC MEDIUM AND ITS INTERACTION WITH AN INTERSTITIAL ATOM. Meissner, N.; Savino, E. J.; Willis, J. R.; Bullough, R. (Atomic Energy Research Establishment, Harwell, Eng.). Phys. Status Solidi (b); 63: No. 1, 139-151(1 May 1974).

Several explicit expressions for the distortion field of an elliptical dislocation loop in a general anisotropic medium are presented. These are used to evaluate the interaction energy between an interstitial dislocation loop in copper and a nearby interstitial atom. The interstitial atom is represented by either a simple spherical inclusion or by realistic Kanzaki forces for its dumb-bell configuration. The effects of both the microscopic anisotropy of the point defect and of the elastic anisotropy of the body on the form and magnitude of the interaction energy are thus exposed. (auth)

13265 ELECTRON IRRADIATION OF GOLD BELOW 2K. Gwozdz, P. S. Urbana, IL; University of Illinois (1973). 143p. University Microfilms Order No. 74-5582.

Thesis (Ph. D.).

Gold (99.9999% purity) was irradiated by 2.5-MeV electrons below 2°K. Damage production was monitored by measuring the dc resistivity of the gold. The production rate $d\rho/d\Phi$ (change in resistivity per integrated electron flux) was found to (a) be enhanced by the presence of quenched vacancies at extremely low values of integrated flux, (b) be attenuated by the presence of quenched vacancies at higher values of integrated flux, (c) decrease with increasing Φ particularly at the lowest values of Φ, (d) increase with increasing $d\Phi/dt$ (beam flux). Thermal recovery of resistivity was observed as low as 2.3°K. The recovery in the range 2.3 to 30°K was found to (a) be enhanced by the presence of quenched vacancies, (b) be attenuated by the presence of silver impurities, (c) increase with increasing Φ. These observations are consistent with the hypothesis that the interstitial in gold undergoes long range migration either during electron irradiation at 1.6°K or during annealing at 1.95°K. (Diss. Abstr. Int., B)

13266 ELECTRON-IRRADIATION-INDUCED DAMAGE PRODUCTION EFFECTS IN LIGHTLY DOPED n- AND p-TYPE α TIN. Myhra, S.; Gardiner, R.B. (Department of Physics, University of Queensland, St. Lucia, 4067, Australia). J. Appl. Phys. 45: No. 7, 2964-2970 (July 1974).

Irradiations at 4.5 K using 0.675-MeV electrons have been performed on a number of n- and p-type α-tin filaments, with impurity concentrations from 4×10^{15} to 2×10^{17} cm^{-3}. Large and reproducible changes with radiation dose have been observed in the electrical resistivity and the thermoelectric power, resulting from changes in carrier concentrations and carrier scattering. It is shown that a model, which requires that the induced defects behave as acceptor sites, accounts satisfactorily for the experimental results. A carrier removal rate of 0.6 ± 0.1 cm^{-1} is deduced and is compared to the theoretical damage production rate of 1.6 ± 0.3 cm^{-1}; this indicates that only a fraction of the induced defects are active as carrier removal centers. Mobilities (μ_e and μ_h) have been calculated as functions of impurity and defect concentrations. It is found that the observed changes in the polarity of the thermoelectric power with dose can be accounted for qualitatively. (auth)

Other Materials

Refer also to abstracts 12344, 12808, 12809, 13174, 13195, 13196, 13203, 13204, 13260, and 14628.

13267 ADSORPTION OF HYDROGEN ON W(110): ELECTRON STIMULATED DESORPTION. King, D. A.; Menzel, D. (Technische Univ., Munich). Surface Sci.; 40: No. 2, 399-404(Nov 1974).

Electron stimulated desorption (ESD) of H from W(110) plane is compared with ESD from W(100) plane. The results for the (100) plane highlight the unique behavior of the (100) plane, where the ratio of the H^+ ion desorption cross sections for the high coverage (1×1) and the low coverage $c(2\times2)$ structures is $<10^{-2}$, and suggests that on the (100) plane a more dramatic change occurs in the adlayer as the coverage is increased than simply the incurrence of lateral interactions. (JRD)

13268 SPATIAL DISTRIBUTIONS OF H_2 DESORBED FROM Fe, Pt, Cu, Nb, AND STAINLESS STEEL SURFACES. Bradley, T. L.; Stickney, R. E. (Massachusetts Inst. of Tech., Cambridge). Surface Sci.; 38: No. 2, 313-326(Jul 1973).

The spatial distributions of H_2 molecules desorbed from polycrystalline Fe, Pt, Cu, Nb, and stainless steel (type 304) surfaces were measured with a rotatable ionization gage. Prior to cleaning the surfaces by ion bombardment or by oxidation, the AES (Auger electron spectroscopy) spectra indicated that all of the sample surfaces were highly contaminated. (S, C, and P were the predominant impurities.) The spatial distributions measured under these conditions were considerably narrower than the commonly-assumed diffuse distribution; i.e., the concentration of desorbed molecules was higher in the vicinity of the surface normal than for the case of diffuse emission represented by $\cos\theta$, where θ is the angle of inspection measured from the surface normal. These measured distributions may be described approximately by the form $\cos^d\theta$, where d ranges from ~2.5 for Nb to ~7 for Fe. However, as the surfaces were cleaned, the spatial distributions for Fe, Pt, and Nb tended to become diffuse (i.e., $d \to 1$), which is consistent with the trend observed previously for polycrystalline and single-crystal Ni. Copper proved to be an exception to this trend, since its distribution was far from being diffuse (i.e., $d \simeq 4$) when the surface appeared to be clean according to our AES measurements. It is suggested that this unusual characteristic of Cu is a consequence of an activation energy barrier associated with the dissociative adsorption of hydrogen on Cu. (auth)

13269 RADIATION DEFECTS PRODUCED IN GAMMA-IRRADIATED DL-VALINE·HCl CRYSTALS. Komar, I. M.; Nikolov, O. T.; Biblii, V. M. (Kharkov State Univ.). Visn. Kharkiv. Univ., Radiofiz.; No. 92, 89-90(1973). (In Ukrainian).

The EPR spectrum of active radiation defects and the form of gamma-irradiated (^{60}Co) DL-valine·HCl were determined and interpreted. The results indicated that the structure of these defects is the same as in other valines and has the form $(OH_2)_2$ CCH (N^+H_3) COO^-. (tr-auth)

13270 RADIATION TREATMENT OF MATERIALS. Mytelka, A. I.; Manganelli, R. M. (to Research Corp.). Canadian Patent 910,232. 19 Sep 1972.

A method for destroying azo dyestuffs in waste water is described. Ferrous sulfate (or a similar compound) is added to

the waste water which is made slightly alkaline and air is bubbled through it in the presence of gamma rays (or other radiation). (CAN)

13271 ACCEPTOR IMPURITY ASSOCIATED DEFECTS IN SILICON. Fang, P. H.; Hirata, M. (Boston Coll., Chestnut Hill, MA). Jap. J. Appl. Phys.; 13: No. 2, 355-356(Feb 1974).

13272 INFRARED STUDIES OF HYDROGENATED $SrCl_2$: RE^{3+} CRYSTALS. Sinnema, S. G.; den Hartog, H. W. (Univ. of Groningen, Netherlands). Phys. Status Solidi (b); 62: No. 1, 103-111(1 Mar 1974).

Localized vibrations of hydride ions in hydrogenated $SrCl_2$: RE^{3+} (rare earth) single crystals are studied with ir spectroscopy. In moderately hydrogenated crystals doped with La^{3+}, Ce^{3+}, or Pr^{3+} two doublets are observed at about 1050 and 700 cm^{-1}. The position and the splitting of the high frequency doublet depend upon the dopant whereas only the position of the low frequency doublet is RE-dependent. The high frequency doublet is ascribed to a complex consisting of a substitutional trivalent lanthanide ion and a substitutional hydride ion in nearest neighbor positions (C_{3v} oscillator). The low frequency pair is due to a localized vibration of an interstitial hydride ion neighboring a substitutional RE^{3+} ion (C_{4v} oscillator). The positions of the individual lines in the C_{4v} doublet are calculated for $SrCl_2$: La-H, and are in good agreement with experiment. (auth)

13273 MÖSSBAUER STUDIES OF ELECTRIC HYPERFINE INTERACTIONS IN ^{234}U, ^{236}U, ^{238}U. Monard, J.A.; Huray, P.G.; Thomson, J.O. (Department of Physics, The University of Tennessee, Knoxville, Tennessee 37916 and Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). Phys. Rev. B 9: No. 7, 2838-2845 (1 Apr 1974).

The nuclear γ resonances for ^{234}U, ^{236}U, and ^{238}U in the compound $(UO_2)Rb(NO_3)_3$ have been observed using sources of PuO_2 and $PuAl_4$. Nuclear deformations of the U isotopes are observed to change through the ratios of the electric quadrupole moments. Using previous B(E2) measurements the electric field gradient at the uranium site has been calculated for this compound from our data. The isomer shift of ^{234}U has been measured for $(UO_2)Rb(NO_3)_3$ and for the two sources PuO_2 and $PuAl_4$. Calculations of electronic charge density changes at uranium nuclei between source and absorbers give a fractional decrease in the rms nuclear radius in the transition from the ground to the excited state of $(\delta\langle r_n^2\rangle/\langle r_n^2\rangle)234_U = (-12.2 \pm 5.9) \times 10^{-4}$. (auth)

13274 EXCHANGE OPTICS IN Gd-DOPED EuO. Schoenes, J.; Wachter, P. (Laboratorium für Festkörperphysik, ETH Zürich, Hönggerberg CH-8049 Zürich, Switzerland). Phys. Rev. B 9: No. 7, 3097-3105 (1 Apr 1974).

This paper is concerned with magneto-optical properties of EuO single crystals, doped with up to 5-at.% Gd. The optical absorption and the Faraday rotation have been measured above and below the magnetic-ordering temperatures and in various magnetic fields. In addition the reflectivity between 13 eV and 250 μm has been observed and the Curie temperature has been determined. The measurements permit the evaluation of the magnetic short- and long-range order. The exchange interaction between free electrons and 4f spins can be determined and is found to decrease with increasing doping. The analysis of the optical data permits the derivation of the carrier concentration, their mobility, and temperature dependence. The carrier concentration shows an exchange-induced ionization near T_C for nondegenerate samples and the mobility has a sharp minimum at T_C. The transport parameters also reflect the fact that the electron-4f-spin interaction decreases with increasing Gd concentration, probably owing to electrostatic-shielding effects. (auth)

13275 THERMOELASTIC RELAXATION NEAR THE CURIE POINT OF EuO. Barmatz, M.; Golding, B. (Bell Laboratories, Murray Hill, New Jersey 07974). Phys. Rev. B 9: No. 7, 3064-3073 (1 Apr 1974).

An extensive investigation of the acoustic properties of thin EuO reeds has been carried out near the magnetic critical temperature T_C = 69.3 K. The main results are the observation of an enhanced damping and velocity dispersion of flexural modes in the frequency range 0.4-3 kHz as $T \to T_C$. These experimental findings are quantitatively described by Zener's theory of thermoelastic relaxation, taking into account the strong temperature dependences of thermodynamic and transport properties near T_C. The temperature dependences of the adiabatic and isothermal Young's-modulus sound velocities are also obtained. Pippard relations are used to determine the thermodynamic quantities (dP/dT), (dS/dT), and (dS/dP) along the transition line. (auth)

13276 SHORT-LIVED COLOR CENTERS IN THE PULSE RADIOLYSIS OF Al_2O_3 CRYSTALS AT HIGH TEMPERATURES. Vinogradov, G. A.; Shubin, V. N.; Levshina, T. M.; Zorin, D. M. (Inst. of Electrochemistry, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 7: No. 6, 479-480(1973).

Translated from Khim. Vys. Energ.; 7: No. 6, 543-545(1973).

The pulse radiolysis method was used to investigate the short-lived color centers produced in the crystal Al_2O_3 + 0.0005 Cr in the temperature range 720 to 1270°K. Treatment of the integral spectrum by resolution into Gaussian curves enabled a band to be separated with the parameters λ_{max} = 470 nm and half-width $\delta \sim 1$ eV. It is shown that this absorption may be caused by electrons localized in the form of low-radius polarons. (auth)

13277 KINETICS OF AN ATOM DIFFUSING IN ONE DIMENSION: HYDROGEN IN QUARTZ. Sosin, A. (Univ. of Utah, Salt Lake City). pp 136-138 of Proceedings of the Twenty-Seventh Annual Frequency Control Symposium. Washington, DC; Electronic Industries Association (1973).

From 27th annual frequency control symposium; Cherry Hill, New Jersey, USA (12 Jun 1973). See CONF-730622-.

The time dependence of frequency recovery at 306°K of pulse-irradiated quartz is analyzed and shown to be inconsistent with the diffusion of a specie in three dimensions, but follows well diffusion in one dimension. The main feature which distinguishes these cases is a $t^{-\frac{1}{2}}$ time dependence of the recovery. No extended region for a $t^{-\frac{1}{2}}$ dependence is possible in three-dimensional diffusion. An extensive $t^{-\frac{1}{2}}$ dependence is predicted in one-dimensional diffusion, paralleling the observation that this holds for some three decades in time and over 80% of the recovery. Having established one-dimensional diffusion in frequency recovery, it is shown that acoustic relaxation found at 115°K and a long time component of conductivity recovery found near 300°K, as well as the frequency recovery, all appear to originate in a common mechanism — the diffusion of H^+ in one dimension with an activation of approximately $\frac{1}{4}$ electron volt. (auth)

13278 INFLUENCE OF CRYSTAL LATTICE ON MULTIPLE SCATTERING OF ELECTRONS. Tsekhanovskii, I. A.; Vorobev, S. A. (Polytechnical Inst., Tomsk, USSR). Phys. Status Solidi (b); 62: No. 2, K63-K65(1 Apr 1974).

The intensity distributions of the swift electrons from a (^{90}Sr + ^{90}Y) radioactive source behind an 8 μm Si single crystal were measured. The angular divergence of the incident beam was about 0.1°. Photographic records of the angular distributions of the transmitted electrons for different incidence directions relative to the ⟨111⟩ Si axis are included. The observed patterns are more complex in their intensity distribution than that expected from the ordinary multiple scattering theory. Obviously the less intense portions correspond to low index planar directions and the ⟨111⟩ crystallographic axis. The radial "deficit" streaks are surrounded on each side by an enhanced intensity that may be caused by anomalous transmission of the electrons close to the planar directions. (auth)

13279 CHEMISTRY AND THERMODYNAMICS OF MOLTEN SALT REACTOR FUELS. Baes, C. F. Jr. (Oak Ridge National Lab., TN). J. Nucl. Mater.; 51: No. 1, 149-162(May 1974).

A fairly detailed knowledge of the chemistry and thermodynamics of molten salt breeder reactor fuels, typically $LiF-BeF_2-ThF_4-UF_4$ (72-16-12-< 1 mol %), has been gained from measurements of heterogeneous equilibria involving various gases (e.g. HF, H_2O) and solids (usually oxides). This information combined with the thermochemical data available for the pure compounds has given formation free energies for the fuel components. Their entropies can be estimated from the known entropies of the corresponding solid oxides and the charge on the cation. Their activity coefficients depend primarily on the mol % of LiF in the salt mixture. The solubility of oxides generally decreases with the square of the cation charge divided by the radius. Thus the actinide dioxides and, especially, Pa_2O_5 (or an addition compound of it) are of low solubility. Pourbaix diagrams are presented which summarize the conditions of redox potential and oxide concentration wherein the fuel may be contained without significant corrosion or precipitation reactions, or conditions wherein selective oxide precipitation may be carried out for purposes of fuel reprocessing. (auth)

13280 OPTICAL POLARIZATION SENSITIVITY OF LEAD MOLYBDATE. DeBenedictis, L.C.; Lucero, J.A. (Electro-Optical Systems, Xerox Corporation, Pasadena, California 91107). Appl. Phys. Lett. 25: No. 1, 62-64 (1 July 1974).

The optical deflection efficiency of an acousto-optic modulator with a lead molybdate interaction medium has been measured at optical wavelengths in the region 442-1152 nm. The crystal orientation was such that the acoustic beam propagated along the optic axis and the optical beam near the a axis. The dependence of the relative figure of merit on optical wavelength and polarization has thus been determined. The results indicate that the figure of merit M_2 is independent of the optical polarization at 633 and 1152 nm, but that a considerable and unexpected sensitivity to polarization occurs between 442 and 515 nm. (auth)

13281 FORMATION OF DEFECTS IN LITHIUM-DOPED GERMANIUM DUE TO BOMBARDMENT WITH FAST NEUTRONS. Konopleva, R.F.; Novikov, S.R. (B. P. Konstantinov Leningrad Institute of Nuclear Physics, Academy of Sciences of the USSR, Gatchina). Sov. Phys.-Semicond. 7: No. 7, 906-908 (Jan 1974).

A study was made of the influence of irradiation with fast reactor neutrons on the electric and photoelectric properties of germanium doped with lithium up to $\sim (2\text{–}8)\cdot 10^{15}$ cm^{-3}. No energy levels of the radiation defects appeared in the forbidden band up to the compensation point. The initial rate of removal of electrons was anomalously high ($\sim$400 cm^{-1}). After the conversion to p-type conduction the temperature dependences log p=f(1/T) indicated the presence of levels with the activation energies $E_v+0.1$ eV and $E_v+0.01$ eV. An analysis of the results obtained indicated that complexes formed from radiation-generated vacancies and LiO^+ played the dominant role in the compensation. These complexes had levels near the valence band whereas the levels at $E_v+0.01$, $E_v+0.1$, and $E_c-0.2$ eV were attributed to the $[LiO^+]V_2$ complexes. (auth)

13282 INFLUENCE OF DONOR IMPURITIES ON THE KINETICS OF ANNEALING OF RADIATION DEFECTS IN GERMANIUM. Basman, A.R.; Gerasimov, A.B.; Gogotishvili, M.K.; Dolidze, N.D.; Kasparyan, K.I.; Kakhidze, N.G.; Konovalenko, B.M. (A. F. Ioffe Physicotechnical Institute Academy of Sciences of the USSR, Leningrad). Sov. Phys.-Semicond. 7: No. 7, 922-924 (Jan 1974).

An investigation was made of the kinetics of isochronous annealing of germanium doped with various amounts of As and Sb irradiated at T=77°K with 5-MeV electrons, and converted to p-type conduction by this irradiation. The annealing temperature at which these samples recovered the original p-type conduction was found to depend on the concentration and nature of the dopant. The various stages of annealing were identified. (auth)

13283 MODEL OF QUASISTABLE LIGHT-SENSITIVE DEFECTS IN GERMANIUM IRRADIATED AT 77°K. Basman, A.R.; Gerasimov, A.B.; Kakhidze, N.G.; Konovalenko, B.M.; Tsertsvadze, A.A. (A. F. Ioffe Physicotechnical Institute, Academy of Sciences of the USSR, Leningrad). Sov. Phys.-Semicond. 7: No. 7, 903-905 (Jan 1974).

The dependence of the sensitivity to light on the annealing temperature was investigated. The temperature at which the strongest sensitivity was obtained, the temperature at which the sensitivity was destroyed, and the activation energy of the destruction of the sensitivity were determined. A model explaining this effect is due to reversible changes in radiation-defect complexes which form an intermediate quasistable state, from which a stable state is produced at higher temperatures. The existence of such an intermediate state is attributed to the anisotropy of the permittivity ϵ of germanium at short distances from a charged center. (auth)

13284 ANNEALING OF ELECTRON-IRRADIATED GERMANIUM AND SILICON. Astakhov, V. M.; Golobokov, Y. N.; Stas', V. F.; Smirnov, L. S. (Institute of Semiconductor Physics, Siberian Branch, Academy of Sciences of the USSR, Novosibirsk). Sov. Phys.-Semicond. (Engl. Transl.); 7: No. 7, 945-946(Jan 1974).

Internal friction measurements were made on electron-irradiated n-type Ge and Si in order to obtain data for a better understanding of the nature of radiation defects in semiconductors. Carefully annealed samples were irradiated with 3.5 MeV electrons along the ⟨112⟩ direction at a temperature of 20 to 30°C. The samples were again annealed and damping decrements Q^{-1} of flexural vibrations were determined at frequencies of 1 to 8 kHz. The temperature dependence of resonance frequency f_1 was also determined. A phenomenological analysis was made of the experimental results, and data are tabulated for four observed peaks. (SFL)

13285 CHANGES IN THE RELATIVE RATES OF GENERATION OF RADIATION DEFECTS IN SILICON. Gerasimenko, N. N.; Zaitsev, B. A.; Panov, V. I.; Smirnov, L. S.; Tishkovskii, E. G. (Institute of Semiconductor Physics, Siberian Branch, Academy of Sciences of the USSR, Novosibirsk). Sov. Phys.-Semicond. (Engl. Transl.); 7: No. 7, 960-961(Jan 1974).

The dose dependence of free-carrier density was determined for n-type silicon irradiated with 3.5 MeV electrons. An increase in the concentration of electrically active defects with increasing density of fast electron flux, tending to saturation at high doses, was observed. Isochronous annealing curves were obtained for oxygen-doped and oxygen-free crystals irradiated with a dose of 8×10^{15} cm^{-2} of fast electrons. The relative effects of temperature during irradiation and level of ionization in the crystal on rate of generation of defects were evaluated. (SFL)

13286 DETERMINATION OF THE ATOMIC-ORBITAL POTENTIALS IN INFINITE SYSTEMS. Zupan, J. (Institute "J. Stefan," University of Ljubljana, Ljubljana, Yugoslavia). Phys. Rev. B 9: No. 10, 4580-4583 (15 May 1974).

A new method for the estimation of the atomic-orbital (AO) potentials in infinite systems is suggested. Using this method the potentials of carbon AO's in graphite, of nitrogen and boron AO's in boron nitride, and of aluminum and nitrogen AO's in aluminum nitride were determined. The energy gap in boron nitride calculated by this method (4.4 eV) is in good agreement with the experimental value of 4.3 eV. (auth)

13287 LCAO CALCULATIONS FOR THE BORON AND NITROGEN INTERSTITIAL IN THE DIAMOND LATTICE. Weigel, C. (State Univ. of New York, Albany); Peak, D.; Corbett, J. W.; Watkins, G. D.; Messmer, R. P. Phys. Status Solidi (b); 63: No. 1, 131-137(1 May 1974).

LCAO–MO cluster calculations based on the extended Hückel theory are carried out for boron and nitrogen atoms in various interstitial configurations in the diamond lattice. The results favor the ⟨100⟩ split interstitial configuration for both the boron and nitrogen interstitial and suggest a change of the energy minimum configuration with charge state. (auth)

13288 EFFECT OF OXYGEN AND COPPER ON THE DEFECT CLUSTER IN NEUTRON-IRRADIATED p-TYPE SILICON. Usami, A.; Tokuda, Y. (Department of Electronics, Nagoya Institute of Technology, Gokiso-cho, Showa-ku, Nagoya, Japan). J. Appl. Phys. 45: No. 7, 2823-2831 (July 1974).

The effect of the oxygen and acceptor concentration and Cu contamination on the defect clusters, found to be produced in p-type silicon by neutron irradiation at room temperature without enclosing the samples by Cd plating, was investigated by using electrical conductivity and Hall effect measurements. The insulating volumes of the defect clusters and the barrier heights formed by the cluster-space charge regions were obtained by Gossick's cluster model. The insulating volumes and barrier heights depended on neither oxygen concentration nor Cu contamination. The insulating volumes decreased with the 0.72 power of the acceptor concentration and the barrier heights increased with the 0.28 power of the acceptor concentration. The acceptor concentration dependency of the insulating volumes could be simply explained by Gossick's cluster model. The recovery of the barrier height was similar to that of the light-sensitive defects by Stein and the trap centers by Nakashima and Inuishi. From the isothermal annealing of the barrier height, the activation energy was found to be about 1.1 eV for both the noncontaminated and Cu-contaminated samples. This activation energy corresponds to the liberating energy of vacancies from clusters. In isochronal annealing above 210 °C, the recovery of the carrier concentration showed the effect of the Cu contamination which could not be observed after irradiation. (auth)

NUCLEAR MATERIALS AND WASTE MANAGEMENT

13289 (WASH-1315) IMPROVED CONTROL OF RADIOACTIVE WASTE AT HANFORD. Stubblefield, F. E.; Jackson, E. B. (USAEC Directorate of Licensing, Washington, D. C.). Jun 1974. 30p. Dep. NTIS $4.50.

Radioactive waste management operations at Hanford for the handling, processing and disposal of solid, liquid, and gaseous wastes are described. (LCL)

13290 COVERING THE NUCLEAR RISK. Cathala, R.; Roche, J. M.; Tregouet, J. A. Nuisances Environ.; No. 27, 57-59(Jan 1974). (In French).

Civil responsibility in the nuclear domain is covered by the law of the 30th October 1968 and the Paris Convention of the 29th July 1960 together with its additional protocol of the 28th January 1964 rendered applicable by the law of the 12th November 1965, which authorized the ratification of the above regulations and by the decree of 6th February 1969 concerning the publication of the corresponding texts. In consequence of the exceptionably serious nature of nuclear risks and the enormous sums of money involved in compensating damage and consequent financial losses, the civil responsibility regime gives priority to the following aspects: immediate compensation to victims; maintaining the level of private investment by involving the state in providing compensation when the latter exceed a certain predetermined amount; and organization of international cooperation. These three aspects extend the rules applicable to compensating and effecting repairs. (FR)

Accountability and Safeguards

13291 (BNWL-1805) SAFEGUARDS INSPECTION ACTIVITIES AND STRATEGIES USING THE HANFORD COMPLEX AS A MODEL. Schneider, R. A.; Sorenson, R. J. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Jan 1974. Contract AT(45-1)-1830. 128p. Dep. NTIS $9.50.

Following brief descriptions of safeguards systems and techniques, inspection strategies, and the Hanford Complex, information is presented on inspection activities for assurance that a facility has the capability to safeguard material adequately, that it is in fact employing that capability satisfactorily, and that additional independent assurances are provided to check both the capability and performance of facility safeguard activities for effectiveness in preventing or detecting material diversion. Implementation at the Hanford Complex of inspection methods to achieve these three levels of assurance are discussed. (LCL)

13292 (BNWL-SA-5023) MEASUREMENT CONTROL PROGRAM FOR NUCLEAR MATERIALS ACCOUNTING. Brouns, R. J.; Roberts, F. P.; Schneider, R. A. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). [nd]. 18p. (CONF-740622-2). Dep. NTIS $4.00.

From meeting of institute of nuclear materials management; Atlanta, Georgia, USA (19 Jun 1974).

The function of a measurement control program for nuclear materials accounting is to monitor and control the quality of the SNM measurements that are involved in material balances. The quality is monitored by collecting data from which the measurement error variances (both random and systematic) can be calculated and is controlled by data evaluations and other activities outlined below. Measurement control is needed in the nuclear industry to provide current estimates of measurement errors for calculating the limit of error of material-unaccounted-for (LEMUF) in material balances. A key test of material control is that the magnitude of MUF does not exceed a value that can be attributed, with reasonable probability, to the cummulative effect of measurement error. Random and systematic errors occur whenever quantities of SNM are weighed (or volumes measured), sampled and analyzed. Each of these operations has several sources of error. Random error is estimated by analyzing the data from replicate measurements of items and samples. Calibrations and standardizations are the normal techniques for eliminating bias and determining the systematic error of measurements. Replicate measurements and calibrations must be carried on continually to provide up-to-date error data during each material balance period. (auth)

13293 (KFK-905) QUANTIFICATION OF CONTAINMENT MEASURES USED IN SAFEGUARDS. Avenhaus, R.; Gruenbaum, L.; Nentwich, D. (Kernforschungszentrum Karlsruhe (F. R. Germany). Projekt Spaltstoffflusskontrolle; Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Angewandte Systemtechnik und Reaktorphysik). Jun 1973. 38p. INIS.

An attempt was made to formulate quantitatively the effect of containment measures in the framework of a general safeguards system and to find an optimal combination of containment and material accountancy measures. In general terms quantification is explained and criteria are developed. The usefulness of containment measures with respect to these criteria is discussed. As an application, the shipper receiver problem is considered in some detail. The problem of safeguarding plutonium storage is analyzed quantitatively with the help of a general game theoretical model developed earlier. A cost optimization with a fixed probability of detection as a boundary condition is carried through. Here, the variables are the number of inspections per year and the number of seals to be identified per inspection. The results which depend on several parameters of the model, e.g. quality and costs of seals, and inspection man day costs, are discussed. Possible further extensions, practical applications and experimental tests in this field are considered. (GE)

13294 (SLA-74-5431) FIELD TESTING OF A SYSTEM FOR COMMUNICATION WITH COMMERCIAL SNM SHIPMENTS. Sellers, T. A.; Sonnier, C. S.; de Montmollin, J. M. (Sandia Labs., Albuquerque, N. Mex. (USA)). 26 Jun 1974. 18p. (CONF-740608-11). Dep. NTIS $4.00.

From annual meeting of the American Nuclear Society; Philadelphia, Pennsylvania, USA (23 Jun 1974).

Tests with an experimental hf system simulating a portion of a nationwide communication system being developed for transportation safeguards demonstrated that hf transmission of short digital messages can be both operationally simple and highly reliable. To obtain those objectives it is necessary to incorporate both frequency and space diversity, and, less important, repetitive transmissions. If message traffic is limited to short digital messages at a low duty cycle, automatic switching and controls can be employed to obtain high reliability without compromising operational simplicity. Detailed engineering design is now underway to provide a fully operational system in FY 1975. (auth)

Disposal and Storage

Refer also to abstract 12697.

13295 (BNWL-1900(Vol. 1)) HIGH-LEVEL RADIOACTIVE WASTE MANAGEMENT ALTERNATIVES. Section 1. Summary. Section 2. Background and Data Base. Section 3. Evaluation Methodology. Schneider, K. J.; Platt, A. M. (eds.). (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). May 1974. Contract AT(45-1)-1830. 458p. Dep. NTIS $10.60.

A comprehensive study is presented of potential alternative methods for the long-term management of high-level radioactive wastes from nuclear power. Disposal in space and in terrestrial locations, i.e., in geologic deposits, seabeds, and ice sheets, is considered. Information is compiled on the technical feasibility, safety, cost, environmental considerations, policy conflicts, public attitudes, and research and development needs related to high-level radioactive waste disposal; characteristics of high-level wastes; and predictions on the quantity of wastes which will result from nuclear power development. (LCL)

13296 (BNWL-1900(Vol. 2)) HIGH-LEVEL RADIOACTIVE WASTE MANAGEMENT ALTERNATIVES. Section 4. Geologic Disposal. Schneider, K. J.; Platt, A. M. (eds.). (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). May 1974. Contract AT(45-1)-1830. 259p. Dep. NTIS $7.60.

The disposal of high-level radioactive wastes in geologic formations is discussed in detail. Disposal in salt deposits has been studied extensively in other AEC programs and is included here only in the overall study matrix. The geologic disposal concepts were studied on a generic and systematic basis, with studies aimed at inherent characteristics. No attempts were made to define the concepts in detail or to optimize any of the concepts. General considerations relevant to more than one concept are described. Details of individual disposal concepts are discussed including a description of the concepts; waste management systems requirements beginning with discharge of high-level liquid waste from a plant reprocessing "spent" nuclear fuel and ending with final waste emplacement in a geologic formation; concept related geologic considerations; technical feasibility; concept safety; research and development needs, including estimated costs; time required to commission, and estimated capital and operating costs associated with a fa-

cility for disposal of commercially generated radioactive waste; and policy, environmental, and public response considerations. (LCL)

13297 (BNWL-1900(Vol. 3)) HIGH-LEVEL RADIOACTIVE WASTE MANAGEMENT ALTERNATIVES. Section 5. Ice Sheet Disposal. Section 6. Seabed Disposal. Schneider, K. J.; Platt, A. M. (eds.). (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). May 1974. Contract AT(45-1)-1830. 310p. Dep. NTIS $7.60.

The overall concept of disposing of high-level radioactive waste in ice sheets is presented. Information is given on radioactive waste management beginning with the transport of solidified high-level waste from a fuel reprocessing plant to the ice sheet disposal site; site operations required prior to disposal; characteristics of ice sheets in Greenland and Antarctica; systems requirements for the ice sheet disposal concept; operation of the site during disposal; technical feasibility of the concept; research and development requirements; costs; time requirements; public response; policy; and environmental impact. (LCL)

13298 (BNWL-1900(Vol. 4)) HIGH-LEVEL RADIOACTIVE WASTE MANAGEMENT ALTERNATIVES. Section 7. Waste Partitioning. Section 8. Extraterrestrial Disposal. Section 9. Transmutation Processing. Schneider, K. J.; Platt, A. M. (eds.). (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). May 1974. Contract AT(45-1)-1830. 463p. Dep. NTIS $10.60.

The separation of high-level radioactive waste into fractions of different half-lives, extraterrestrial disposal, and transmutation processing are discussed individually. Separations technologies and their applicability for removing actinides and long-lived fission products from high-level wastes are reviewed, and evaluated, and areas of further research and development related to these technologies are identified. The concept of extraterrestrial disposal presumed that it is more practical to transport only the transuranium elements to space than to ship the total waste. The space disposal concept is described and discussed in terms of transportation requirements, capsule design, safety, research and development needed, time and money costs, public response, policy, and environmental considerations. Finally, the concept of eliminating the waste by transmuting the long lived waste constituents into short-lived radioactive or nonradioactive isotopes is described. Devices considered for transmutation processing included accelerators, fission and thermonuclear explosives, fission reactors, and fusion reactors. The overall concept and specific device concepts are evaluated for technical feasibility, safety, costs, development requirements, public response, policy, and environmental impact. Comments by peer reviewers are included in an appendix. (LCL)

13299 (BNWL-B-141) DATA FOR PRELIMINARY DEMONSTRATION PHASE OF THE "ENVIRONMENTAL QUALITY INFORMATION AND PLANNING SYSTEMS (EQUIPS)". (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Dec 1971. Contract AT(45-1)-1830. 307p. Dep. NTIS $18.50.

Data are presented on the quantities of radioactive wastes expected as the result of nuclear power plant operations in 1967, 1970, 1975, and 1980. Information is included on radioactive wastes from uranium milling and conversion, nuclear fuel enrichment, fuel fabrication, reactor operations, and fuel reprocessing. Current and future programs for the ungerground storage and disposal of liquid and solid radioactive wastes are discussed. This disposal information is necessary for determining the environmental contamination effects of radioactive waste management systems. (LCL)

13300 (BNWL-B-223-10) ADVANCED WASTE MANAGEMENT STUDIES. Progress Report, January–March 1974. Schneider, K. J. (comp.). (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). May 1974. Contract AT(45-1)-1830. 80p. Dep. NTIS $5.45.

Studies of advanced methods for radioactive waste disposal were undertaken to determine the feasibility of long-term waste management schemes, to identify the research and development necessary for their establishment, and to estimate the time and money costs of selected systems. Progress is reported on radioactive waste disposal in geologic deposits, ice sheets, and the seabed; transmutation processing to change long-lived radioactive waste into short-lived waste or into stable isotopes; safety evaluations of waste disposal concepts; and waste management decision analysis. (LCL)

13301 (KY-657) URANIUM HEXAFLUORIDE TAILS STORAGE CYLINDERS. Glenn, M. L. (Paducah Gaseous Diffusion Plant, Ky. (USA)). 17 Jun 1974. Contract W-7405-eng-26. 10p. Dep. NTIS $4.00.

The condition of UF_6 storage cylinders was evaluated. Wall thickness measurements on cylinders in use for up to 17 years indicate that the corrosion is about 2 mils per year. An additional life of 30 years is predicted for even the oldest cylinders. (auth)

13302 (ORNL-tr-2811) METHOD FOR CHOOSING SAFE DISPOSAL CONDITIONS FOR SOLIDIFIED WASTES DEPENDING ON PROPERTIES AND SPECIFIC ACTIVITY. (Oak Ridge National Lab., Tenn. (USA)). 1973. Translated by Martha Gerrard from the Russian. 25p. Dep. NTIS $4.25.

In selecting the conditions for disposal of radioactive wastes, it is necessary to determine the need for hydro-insulation and hermetic sealing of the burial containers in order to prevent dispersal of radioisotopes and contact of the wastes with water during storage; the maximum permissible temperature during storage; the need for heat removal; and the conditions for heat transfer. The selection of the conditions is based on laboratory studies and calculations and on experimental storage of solid wastes under actual conditions. Methods are recommended which should ensure obtaining data that can be used for evaluating the behavior of wastes under actual conditions of burial, and accounting for methodological errors which may lead to distortion of results. The conditions selected for storage of solidified wastes should primarily ensure that no radioisotopes will be released to the environment. (auth)

13303 RADIOACTIVE WASTE STORAGE IN SALT FORMATIONS. Franke, H.; Mosler, H.; Spann, H. C. (Brennstoffinstitut, Freiberg i. B.). Kernenergie; 17: No. 4, 101-106(Apr 1974). (In German).

The appropriateness of salt deposits for storing radwaste is discussed and the necessary pre-studies for clearing up the interaction between storage medium and bedrock are presented. Moreover, the technology of storing both low- to medium-level and high-level radwaste is briefly described. Finally, problems of long-term safety in storing radwaste in rock salt are dealt with. (auth)

13304 CLASSIFICATION OF RADIOACTIVE WASTES. Gera, F. (Comitato Nazionale per l'Energia Nucleare, Rome). Health Phys.; 27: No. 1, 113-121(Jul 1974).

Various proposals of classification of radioactive wastes are reviewed. It is suggested that the need for standardized waste categories could be satisfied by simply defining the meaning of the terms presently in common use. In the past the classification of radioactive wastes has been considered necessary in order to facilitate communication, but has not been intended to provide indications on subsequent operations of treatment, conditioning, storage and disposal. In addition to a waste classification of such limited scope, it would be very advantageous to adopt a classification of an operational nature. It is suggested here that the waste should be classified and segregated on the basis of the duration of required containment. A simple and probably sufficient subdivision would be in two groups: (1) the first one formed by wastes requiring relatively short-term containment and acceptable for disposal by shallow burial; (2) the second group would contain wastes requiring long-term containment and destined for disposal in deep geologic formations. (auth)

13305 OXIDATION STUDIES OF THE ERBIUM HYDRIDE SYSTEM. Fernandez, E.J.; Holloway, M.D. (General Electric Company, Neutron Devices Department, St. Petersburg, Florida 33733). J. Vac. Sci. Technol. 11: No. 3, 612-613 (May 1974).

Experiments to elucidate the oxidation mechanism responsible for the deterioration of hydrided erbium films (hydrogen isotope storage devices) have revealed that excessive surface oxidation damage is due to the hydrogen reaction. The addition of a gettering material during hydriding has been found to retard such oxidation. (AIP)

Handling Equipment and Procedures

Refer also to abstract 13075.

13306 ANOMALIES OF CRITICALITY. Clayton, E. D. (Battelle Pacific Northwest Labs., Richland, WA). Nucl. Technol.; 23: No. 1, 14-27(Jul 1974).

During the development of nuclear energy, a number of apparent anomalies have become evident in nuclear criticality. Some of these have appeared in the open literature and some have not. Extrapolation of existing data, without knowledge of the "anomalies," could lead to potentially serious consequences. The known "anomalies" include, but are not limited to the following: relationship between criticality in finite spheres and reflected cubes; effect of added scatterers on the criticality of infinite slabs; a small mass concept whereby criticality could be achieved with less than an ounce of fissile material in the form of a single small foil ≈0.2 mil thick; effects of progressive water flooding on the criticality of interacting arrays of fissile materials in storage vaults; effect

of mixing metal and fissile bearing aqueous solutions together in the same vault; criticality of coupled fast-thermal systems composed of small plutonium metal spheres surrounded by aqueous plutonium-bearing solutions; criticality of slightly enriched uranium and the negative buckling core; effects of density changes in spherical cores with weakly absorbing reflectors (external moderation); appearance of critically unbounded regions (of infinite masses) for slightly enriched uranium; criticality in the earth; criticality in the universe; criticality of even-n nuclides beginning with the naturally occurring element, $^{231}_{91}$Pa; and beyond Californium projection of the "micro" critical mass for the doubly-closed shell super heavy magic nuclei of the future. (auth)

13307 FURTHER OBSERVATIONS OF APPARENT CHANGES IN THE STRUCTURE OF 3C 273 AND 3C 279. Kellermann, K.I.; Clark, B.G. (National Radio Astronomy Observatory); Shaffer, D.B.; Cohen, M.H.; Jauncey, D.L.; Broderick, J.J.; Niell, A.E. Astrophys. J. Lett. 189: No. 1, L19-L22 (1 Apr 1974).

During 1972 we continued to use the Goldstack interferometer to observe the variable radio sources 3C 273 and 3C 279. It is possible to fit the data with models consisting of three fixed collinear components which individually vary in intensity and size, or with expanding double models. (auth)

Transportation

Refer also to abstract 13294.

13308 (MLM-2145) SAFETY ANALYSIS REPORT FOR PACKAGING (SARP): ATMX-500 RAILCAR NUCLEAR PACKAGING. Griffin, J. F.; Peterson, J. B.; Edling, D. A.; Rodriguez, L. F. (Mound Lab., Miamisburg, Ohio (USA)). 31 May 1974. Contract AT(33-1)-Gen-53. 72p. Dep. NTIS $5.45.

This Safety Analysis Report for Packaging (SARP) makes available to all potential users the technical information and limits pertinent to the modification and use of the ATMX Railcars for which the Department of Transportation has issued special permit No. 5948. This SARP includes discussions of structural integrity, thermal resistance, radiation shielding and radiological safety, nuclear criticality safety, and quality control. Much of the information was previously published in a similar report. A complete physical and technical description of the package is presented. The packaging consists of a specially modified ATMX Series 500 Railcar loaded with DOT Specification steel drums or wooden crates. A nuclear criticality safety analysis which was initially conducted for DOT-SP-6000 containers, in 15-, 30-, and 55-gal sizes, is applicable (except for the 15-gal size) to packaging and shipment of fissile waste material in the ATMX Railcars and is included. The results of the analysis provide the maximum quantities of each fissile isotope which may be shipped as Fissile Class I in 30- and 55-gal drums. A limit of 5 g/ft^3 was established for wooden crates. Design and development considerations regarding the packaging concept and modification of the ATMX-500 Railcar are presented. Tables, dimensional sketches, sequential photographs of the structural modifications, technical references, loading and shipping guidelines, Mound Laboratory's experience in using this container, and a copy of permit DOT-SP-5948 are included. An internal review of this SARP has been performed in compliance with the requirements of AECM 5201-Part V. (auth)

13309 (RLO-SA-74-1) SAFE-SECURE TRANSPORTATION, WHO IS RESPONSIBLE? Garrison, R. F. (USAEC Richland Operations Office, Wash.). 1974. 8p. (CONF-740901-1). Dep. NTIS $4.00.

From fourth international symposium on packaging and transportation of radioactive materials; Miami Beach, Florida, USA (22 Sep 1974).

The imperfections of the worldwide transportation network, our dependence upon it, and views on why there has been no loss of life nor clinically detectable injury due to the hazardous nature of nuclear shipments in over a quarter century are presented. Present legal and moral responsibilities of shippers and carriers, and some thoughts about what shippers should consider prior to release of a nuclear materials shipment into today's transportation environment are discussed. (auth)

13310 (TID-26589) SAFETY ANALYSIS REPORT FOR THE SHIPMENT OF FFTF FUEL IN THE F-144-1 SHIPPING CONTAINER. (Battelle Columbus Labs., Ohio (USA)). 20 May 1974. 74p. Dep. NTIS $6.75.

A safety evaluation of the F-144-1 Shipping Container, which is to be used in the transportation of unirradiated FFTF and other LMFBR fuel element assemblies or fuel pins is presented. The F-144-1 container can carry one fuel element assembly or up to 120 bundled fuel pins. The assemblies will be shipped dry. The safety evaluation was made of the container in accordance with AEC regulations 10-CFR-Part 71 and DOT regulations 49-CFR-Parts 171-179. The results of the evaluation indicate that the package satisfies the standards specified in Subpart C of 10-CFR-Part 71, and radiation dose rates are within the limits specified in Paragraph 173.393 (j) of 49-CFR-Part 173 for mixed shipment on a common carrier. (LCL)

13311 TRANSPORTATION OF RADIOACTIVE MATERIALS IN THE WESTERN STATES. Pollock, W. E.; Rogers, W. M. Jr. Lakewood, CO; Western Interstate Nuclear Board (1974). 143p.

Information and recommendations are presented which may assist member states of the Western Interstate Nuclear Board (WINB) in considering issues related to the transportation of radioactive material. Information is included on the types and amounts of radioactive material involved in present and future transportation in member states; transportation risks; insurance and indemnification for transportation accidents; federal and international regulation of the transportation process; state power to regulate nuclear materials transportation; regulation of the transportation process by states; and emergency preparedness and response. (LCL)

PARTICLE ACCELERATORS

Design, Development, and Operation

Refer also to abstract 12653.

13312 (KFK-EXT-3-72-9) ACCELERATING TESTS ON THE FIRST SECTION OF THE KARLSRUHE SUPERCONDUCTING PROTON ACCELERATOR. Brandelik, A.; Citron, A.; Flecher, P.; Fricke, J. L.; Hietschold, R.; Hochschild, G.; Hornung, G.; Krafft, G.; Kuehn, W. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Experimentelle Kernphysik). Nov 1972. 25p. INIS.

This report is a summary of recent tests made on the first section of the Karlsruhe, superconducting linear accelerator. The following elements were assembled: Cockcroft-Walton injector, chopper-buncher system, and first cryostat. The cryostat contained the first accelerating section and a superconducting quadrupole doublet while dummy sections were placed in the position of the second and third tanks and the second quadrupole doublet, allowing the beam to traverse the entire length of the cryostat. These tests were carried out in March and June 1972. The design field of $E_{TW_{axis}} = 1.155$ MV/m was obtained in stable operation. At an injection energy of 750 keV and the design field on the axis, a maximum energy gain of 380 keV was measured with a continuous proton beam. (GE)

13313 (LBL-2603) EXPERIMENTAL SUPERCONDUCTING ACCELERATOR RING (ESCAR). Avery, R.; Elioff, T.; Garren, A. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). May 1974. Contract W-7405-eng-48. 6p. (CONF-740522-25). Dep. NTIS $4.00.

From ninth international conference on high energy accelerators; Stanford, California, USA (2 May 1974).

The Experimental Superconducting Accelerator Ring (ESCAR) project is for accelerator technology development for which the primary goal is the fabrication and operation of a relatively small proton synchrotron and storage ring employing superconducting magnet elements for the main ring. The machine parameters are listed, and the schedule and plans are outlined. ESCAR will utilize the Bevatron 50-MeV line injector as a proton source. (WHK)

Auxiliaries and Components

13314 (DESY-73-66, pp 687-706) STATUS OF SUPERCONDUCTING ELEMENTS. Elioff, T. (Univ. of California, Berkeley). Dec 1973.

From proceedings of the seminar on e-p and e-e storage rings; Hamburg, Germany (8 Oct 1973).

A few developments of the superconducting program particularly at LBL are reviewed. The development of dc transport magnets, pulsed superconducting elements, and the LBL superconducting accelerator miniproject are discussed. (WHK)

13315 (KFK-EXT-3-71-7(Rev.)) FIELD ABERRATIONS IN SUPERCONDUCTING DIPOLE AND QUADRUPOLE MAGNETS FOR A SUPERCONDUCTING SYNCHROTRON. Green, M. A. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Experimentelle Kernphysik). Jun 1972. 69p. INIS.

This report presents and discusses various kinds of field aberrations that can occur in superconducting dipole and quadrupole magnets. These aberrations are divided into two basic kinds of aberration, those which produce asymmetric multipoles and those which produce symmetric multipoles. Some of the field errors are caused by conductor placement problems; others are caused by various electrical and magnetic phenomena. The tolerance limits that must be put on conductor position are discussed. Methods for preventing and correcting various aberrations are discussed. Finally a method for building model magnets and measuring these magnets to detect, correct, and prevent the various kinds of aberrations which can occur in the copper and superconducting model magnets is presented. (GE)

13316 (NP-20054) PROFILE AND CONTAMINATION OF AN ELECTRON BEAM. Romano, G. (Rome Univ. (Italy). Istituto di Fisica; Istituto Nazionale di Fisica Nucleare, Rome (Italy)). 25 Mar 1974. 8p. Dep. NTIS (US Sales Only) $4.00.

The use of dielectric track detectors for beam monitoring at the Frascati electron synchrotron is described. Nitrocellulose sheets were used to measure the electron beam profile and to measure the γ-ray contamination in the beam. (WHK)

13317 DEVICE FOR SCANNING A CYCLOTRON BEAM. Linev, A. F.; Sakhno, V. I. (Inst. of Nuclear Research, Kiev). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 16: No. 6, 1628-1629 (1973).

Translated from Prib. Tekh. Eksp.; 16: No. 6, 18-19(1973).

The principle of operation and the circuit of a device which allows the shape and position of the beam in the ion duct of a cyclotron to be observed are described. The scanning frequency of 1 Hz is determined by the period of the natural oscillations of a pendulum. The sweep of the observation block is produced by a capacitive pendulum-position pickup. (auth)

13318 STABILIZATION OF THE ACCELERATION MODE IN A MICROTRON. Aleshin, V. M.; Zhulinskii, S. F.; Kudritskii, A. T.; Mirzoyan, A. R. Instrum. Exp. Tech. (USSR) (Engl. Transl.); 16: No. 6, 1630-1631(1973).

Translated from Prib. Tekh. Eksp.; 16: No. 6, 19-21(1973).

A device is described which automatically maintains the ratio between the accelerating and magnetic fields. The results of its experimental investigation are presented. (auth)

13319 INSTRUMENT FOR MEASURING THE SPATIAL PROFILE OF BEAMS. Vishnyakov, V. V.; Zhuravlev, N. I.; Komarov, V. I.; Kosarev, G. E.; Nguyen Man Shat; Sinaev, A. N. (Joint Inst. of Nuclear Research, Dubna, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 16: No. 6, 1632-1635(1973).

Translated from Prib. Tekh. Eksp.; 16: No. 6, 21-24(1973).

A device is described for determining the spatial profile of beams of accelerated particles from the ionization currents that flow through the wire electrodes of the detector (an ionization or proportional chamber, a carpet of proportional counters). The voltages which develop as a result of the storage of the charges created by the ionization currents in the capacitors are applied to an oscilloscope or a multichannel analyzer from field-effect transistors. The device is used to measure the profiles of the extracted proton beams of the synchrocyclotron of the JINR. (auth)

13320 FABRICATION OF A LUMINESCENT SCREEN FOR MEASUREMENT OF THE PROFILES OF CHARGED-PARTICLE BEAMS. Zhil'tsova, L. Ya.; Larin, A. A.; Shafranov, M. D. (Joint Inst. for Nuclear Research, Dubna, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 16: No. 6, 1831-1832(1973).

Translated from Prib. Tekh. Eksp.; 16: No. 6, 184-185(1973).

A method is proposed for fabricating a luminescent screen for measurement of the profiles of charged-particle beams and quantitative measurements of the number of particles by the photometry method. The method ensures uniform distribution of a phosphor of any thickness over the area and high mechanical strength of the phosphor layer. (auth)

13321 APPLICATION OF THE LOGARITHMIC RESPONSE OF SILICON DIODES TO MONITORING BEAM SYMMETRY AND ELECTRON ENERGY. Saunders, J. E. (Ontario Cancer Treatment and Research Foundation, Hamilton). Phys. Med. Biol.; 19: No. 3, 373-378(May 1974).

Results are presented on the operation of p-n junction detectors in the open circuit mode for monitoring beam asymmetry and electron beam energy, using commercially available silicon diodes in a radiotherapeutic 6 MV linear accelerator. (UK)

Ion Optics and Field Calculations

13322 (BUP-64) CALCULATIONS AND MEASUREMENTS OF THE BEAM TRANSPORT AT THE NIELS BOHR INSTITUTE'S TANDEM LABORATORY. Sandvik, G. E. (Bergen Univ. (Norway). Dept. of Physics). Apr 1974. 25p. (In Norwegian). Dep. NTIS (US Sales Only) $4.25.

Following a brief description of the beam transport system, the beam scanners and measurement of absolute beam breadths are described. The measurement of beam emittances is then treated and the method for calculation of beam breadths through the system is presented. The calculations of the beam optics at the spectrograph entrance are finally presented. (NO)

13323 (DESY-73-66, pp 519-592) ACCELERATION OF PROTONS IN DESY. Kumpfert, H. Dec 1973.

From proceedings of the seminar on e-p and e-e storage rings; Hamburg, Germany (8 Oct 1973).

Physical and technical problems related with proton acceleration in the DESY synchrotron are discussed. Three internal notes are reproduced including: Proton acceleration in DESY, Parameters for the storage of an unbunched proton beam in

DORIS, and Bunched proton beam in DORIS. The requirements on the DESY synchrotron beam for injection into DORIS are studied. (WHK)

13324 (KFTI-73-14) SYSTEM OF MEASURING, SETTING, AND CONVERSION OF ELECTROMAGNETIC ANALYZER MAGNETIC FIELD. Denyak, V. M.; Perun, N. V.; Vladimirov, Yu. V.; Nemashkalo, A. A. (AN Ukrainskoj SSR, Kharkov. Fiziko-Tekhnicheskij Inst.). 1973. 14p. (In Russian). INIS.

A wide-range nuclear magnetometer is described, along with the setting and conversion of the frequency of the magnetometer and the control of the magnetic field of the electromagnetic analyzer by a nuclear magnetic resonance signal. (tr-auth)

Storage Rings

13325 (CONF-740522-22) TWO-DIMENSIONAL RESONANCE EFFECTS DUE TO A LOCALIZED BI-GAUSSIAN CHARGE DISTRIBUTION. Ruggiero, A. G. (National Accelerator Lab., Batavia, Ill. (USA)). May 1974. Contract AT(49-8)-3000. 6p. Dep. NTIS $4.00.

From ninth international conference on high energy accelerators; Stanford, California, USA (2 May 1974).

The effect of a nonlinear kick supplied by one beam to the other in a colliding device had already been investigated by E. Keil and J. LeDuff. The nonlinear kick was multiple analyzed and a single resonance was considered, but only the average term and the lowest Fourier mode driving the resonance were taken into account. More recently, A. G. Ruggiero and L. Smith approached the problem again, but with a different technique. They found that it is possible to describe a single resonance taking the exact analytical expression of the nonlinear kick and the contribution of all the higher Fourier modes driving the same resonance. Nevertheless, their calculation was limited to the one-dimensional case. The purpose of this paper is to extend this kind of calculation to the bi-dimensional case. We shall still assume a round beam with bi-gaussian distribution of standard deviation σ. The nonlinear kick is taken to occur lumped over a zero length interval. The main application is the calculation of the motion in proximity of a single, isolated and weak resonance; the calculation of the resonances width; and of the stochasticity limit. Our result for the stochastic limit is higher than the one obtained by Keil. Because of the vastity of the topics only the essential results are reported here. (auth)

13326 (DESY-73-66) PROCEEDINGS OF THE SEMINAR ON E-P AND E-E STORAGE RINGS, HAMBURG, OCTOBER 8-12, 1973. Bienlein, J. K.; Dammann, I.; Wiedemann, H. (eds.). (Deutsches Elektronen-Synchrotron (DESY), Hamburg (F. R. Germany)). Dec 1973. 707p. (CONF-731073-).

Separate abstracts were prepared for the 25 papers presented. (WHK)

For abstracts of individual papers see: 13314, 13323, 13327-13339, 13343, 13344, 13790-13792, 13805, and 13870-13873.

13327 (DESY-73-66, pp 343-356) ISABELLE E-P OPTION. Chasman, R. W. (Brookhaven National Lab., Upton, NY). Dec 1973.

From proceedings of the seminar on e-p and e-e storage rings; Hamburg, Germany (8 Oct 1973).

Modifications to the ISABELLE preliminary design study which allow the addition of an electron ring to the proposed double proton ring are discussed. ISABELLE main parameters, lattice parameters, and performance parameters for e-p collisions at top energy are listed. (WHK)

13328 (DESY-73-66, pp 357-373) EPIC. Rees, G. (Rutherford High Energy Lab., Chilton, Eng.). Dec 1973.

From proceedings of the seminar on e-p and e-e storage rings; Hamburg, Germany (8 Oct 1973).

The present stage of the EPIC Electron-Proton-Positron-Storage-Ring Facility and several options are presented. The proposed location of the storage ring and the magnet lattice, rf system, working points, and luminosities are described. A preliminary cost estimate for some options is given. (auth)

13329 (DESY-73-66, pp 375-426) FEASIBILITY STUDY PETRA. Steffen, K. G. (DESY, Hamburg). Dec 1973.

From proceedings of the seminar on e-p and e-e storage rings; Hamburg, Germany (8 Oct 1973).

The planning and design parameters for the proposed PETRA (Proton-Electron Tandem Ring Accelerator) storage ring are discussed. Four internal notes are reproduced: 1) Preliminary Beam Parameters and RF System for PETRA; 2) 120/15 GeV/c p-e Storage Ring PETRA: Model 1 Layout; 3) Betatron Frequency Shifts for PETRA; and 4) PETRA, Model 1: Orbit and Beam Parameters for the 15 GeV/c Electron Storage Ring ESR. The PETRA system consists of a pre-accelerator SYN which accelerates electrons and protons to 4 GeV/c, an electron storage ring ESR where protons will be accelerated to 120 GeV/c and subsequently electrons of 15 GeV will be stored, and a proton storage ring PSR for 120 GeV/c maximum momentum. (WHK)

13330 (DESY-73-66, pp 427-440) D. C. I. Marin, P. (Laboratoire de l'Accelerateur Lineaire, Orsay, France). Dec 1973.

From proceedings of the seminar on e-p and e-e storage rings; Hamburg, Germany (8 Oct 1973).

The layout and construction status of the DCI electron-positron storage ring are described. (WHK)

13331 (DESY-73-66, pp 441-462) SUPER SPEAR. Richter, B. (Stanford Linear Accelerator Center, CA.). Dec 1973.

From proceedings of the seminar on e-p and e-e storage rings; Hamburg, Germany (8 Oct 1973).

The preliminary design of a 15-GeV single ring variable tune e^+e^- colliding beam system which has good luminosity over an extended energy range is described. The peak luminosity of the e^+e^- ring is chosen to be 10^{32} cm^{-2} sec^{-1} per collision point at 15-GeV per beam. (WHK)

13332 (DESY-73-66, pp 465-517) RESULTS OF THE NAL SUMMER STUDY AT ASPEN. Tigner, M. (Cornell Univ., Ithaca, NY). Dec 1973.

From proceedings of the seminar on e-p and e-e storage rings; Hamburg, Germany (8 Oct 1973).

The colliding of a stored electron beam of 3 to 4 GeV energy with the NAL main ring (MR) proton beam during normal operation for external beam physics is seen to be feasible and desirable. By using equipment now on hand at CEA it is estimated that such an experiment could be brought to the point of doing exciting e-p scattering and accelerator studies on a construction time scale of two years and for a cost of about 5 million dollars. (Not including NAL manpower costs). (auth)

13333 (DESY-73-66, pp 593-602) STACKING OF PROTONS IN DORIS. Kohaupt, R. D. Dec 1973.

From proceedings of the seminar on e-p and e-e storage rings; Hamburg, Germany (8 Oct 1973).

Two schemes for the accumulation of protons in DORIS are briefly described. According to the first scheme the protons are accumulated as an unbunched continuous beam. This is the basic scheme for experiments on high energy physics and therefore has to provide maximum luminosity. According to the second scheme the protons are accumulated as a bunched beam. This scheme is mainly concerned with ep machine experiments to study the proton beam limits, in particular the limits of electron-proton beam-beam interaction, and therefore has to provide maximum particle line density. (WHK)

13334 (DESY-73-66, pp 603-610) e-p MACHINE PHYSICS EXPERIMENTS IN DORIS. Wiedemann, H. Dec 1973.

From proceedings of the seminar on e-p and e-e storage rings; Hamburg, Germany (8 Oct 1973).

Electron-proton colliding beam problems that need to be investigated in DORIS are listed and discussed. DORIS proton beam parameters are compared with other accelerator and storage ring beam parameters, and experimental setups for studying the beam-beam effect are described. (WHK)

13335 (DESY-73-66, pp 611-624) MACHINE STUDIES IN THE ISR. Schnell, W. (CERN, Geneva). Dec 1973.

From proceedings of the seminar on e-p and e-e storage rings; Hamburg, Germany (8 Oct 1973).

Beam parameters in the ISR are listed, and beam dynamic studies are outlined. Beam luminosity limits, transverse instabilities, and longitudinal phase space density and available aperture are discussed. Also, results of longitudinal and transverse Schottky scans are presented and discussed. (WHK)

13336 (DESY-73-66, pp 625-641) PROTON BEAM INSTABILITIES. Keil, E. (CERN, Geneva). Dec 1973.

From proceedings of the seminar on e-p and e-e storage rings; Hamburg, Germany (8 Oct 1973).

Coherent instabilities in storage rings are considered including: (1) longitudinal instabilities of coasting beams, (2) longitudinal instability of bunched beams, (3) transverse instability of coasting beam, (4) transverse instability of bunched beams, and (5) electron-proton instability. Observations in the ISR are reported. (WHK)

13337 (DESY-73-66, pp 643-664) ISR PERFORMANCE REPORT. Huebner, K. (CERN, Geneva). Dec 1973.

From proceedings of the seminar on e-p and e-e storage rings; Hamburg, Germany (8 Oct 1973).

The lifetime of the 2 GeV/c beam was not affected by the presence of a 26 GeV/c beam at 12 A. The computed beam-

beam Q-shift was $\lesssim 4.5 \cdot 10^{-3}$. The lifetime of the aperture limited 2 GeV/c beam was ~30 min roughly compatible with intra-beam scattering. The typical intensity of the 2 GeV/c beam was 5 mA. (auth)

13338 (DESY-73-66, pp 665-679) INTRA BEAM SCATTERING. Piwinski, A. Dec 1973.

From proceedings of the seminar on e–p and e–e storage rings; Hamburg, Germany (8 Oct 1973).

Previous studies of the multiple scattering effects in colliding beams have indicated an increase of all beam or bunch dimensions and an increase of the energy spread. Two factors not previously considered are discussed. These include 1) the energy spread within the beam, i.e. the energy difference of two colliding particles before collision; and 2) the linear part of the dependence of the scattering angle on the coordinates of the betatron oscillation. (WHK)

13339 (DESY-73-66, pp 681-685) SIGNIFICANCE OF TRANSITION ENERGY IN INTRA-BEAM SCATTERING: AN EXAMPLE. Lawson, J. D. (Rutherford High Energy Lab., Chilton, Eng.). Dec 1973.

From proceedings of the seminar on e–p and e–e storage rings; Hamburg, Germany (8 Oct 1973).

Piwinski in his paper "Intra-Beam Scattering" (pp. 665-679, this conference) found that above an energy close to transition energy such scattering causes betatron oscillation amplitudes and momentum spread to increase indefinitely, but below this energy an equilibrium exists. This corresponds roughly to "equipartition" between suitably defined longitudinal and transverse energies. For the special case of non-relativistic particles in an azimuthally symmetrical field, this is demonstrated explicitly by means of a simple physical argument. Also, a note on the cut-off angle for Coulomb intra-beam scattering is presented. (WHK)

13340 (RL-74-25) VACUUM REQUIREMENTS FOR THE PROTON RING OF EPIC. (Science Research Council, Chilton (UK). Rutherford High Energy Lab.). 1973. 30p. Dep. NTIS (US Sales Only) $4.50.

The effects of the vacuum on the circulating proton beam in EPIC are examined. The figures are approximate, and are intended to give orders of magnitude. The following are considered: (a) elastic (Rutherford) scattering through an angle too large to be accepted by the ring; (b) inelastic (nuclear) scattering; (c) multiple elastic scattering which gradually increases the emittance of the beam eventually leading to loss to the walls of the vacuum chamber; (d) the gradual loss of energy of the beam by ionizing collisions and resultant straggling; (e) loss of energy in elastic collisions, and (f) the increase in gas pressure due to desorption from the chamber walls when ionized residual gas atoms are accelerated out of the beam by the space charge of the beam itself. Resonant beam loss mechanisms caused by electrons (formed by ionization of the residual gas) in the beam may be important. Probably the only other limitation of the vacuum in the proton ring is due to background radiation adversely affecting experiments. The radiation is caused by nuclear collisions with residual gas and by high energy beam particles hitting the walls. Since some beam is scattered to the walls by collision with the residual gas, the vacuum pressure again is important. (UK)

13341 (RL-74-26) EDDY CURRENTS IN THE VACUUM CHAMBER OF THE EPIC ELECTRON RING. Bennett, J. R. J. (Science Research Council, Chilton (UK). Rutherford High Energy Lab.). Jan 1974. 3p. Dep. NTIS (US Sales Only) $4.00.

The material and wall thickness of the vacuum chamber must be chosen to minimize eddy current fields from unduly distorting the applied field. It is shown that an aluminium chamber of 4 mm wall thickness is just acceptable. Stainless steel would be very suitable. (auth)

Experimental Facilities

Refer also to abstract 12792.

13342 (COO-1112-249) NEW CRYOSTAT FOR PPT V. Gray, S. W. (Michigan Univ., Ann Arbor (USA). Dept. of Physics). [nd]. 4p. (CONF-740226-2). Dep. NTIS $4.00.

From symposium on high energy physics with polarized beams; Argonne, Illinois, USA (8 Feb 1974).

The construction of a polarized target cryostat is described. A ^{3}He cryostat and a ^{4}He cryostat are incorporated. (WHK)

13343 (DESY-73-66, pp 311-322) EXPERIENCE WITH THE MAGNETIC DETECTOR AT SPEAR AND IDEAS ABOUT DETECTORS FOR LARGE ep FACILITIES. Richter, B. (Stanford Linear Accelerator Center, CA.). Dec 1973.

From proceedings of the seminar on e–p and e–e storage rings; Hamburg, Germany (8 Oct 1973).

The present performance characteristics of SPEAR are listed, and the improvement program is outlined. Also, detectors for e^+e^- annihilation processes, the magnetic detector, and detectors for high energy ep rings are discussed. (WHK)

13344 (DESY-73-66, pp 325-341) PEP (PROTON–ELECTRON–POSITRON-COLLIDING BEAM SYSTEM). Elioff, T. (Univ. of California, Berkeley). Dec 1973.

From proceedings of the seminar on e–p and e–e storage rings; Hamburg, Germany (8 Oct 1973).

The planning, design and operation parameters, and physics expectations of a Proton–Electron–Positron colliding beam system are discussed. (WHK)

13345 (LAL-RI-73-5) RESEARCH AND DEVELOPMENT OF A WIDE SOLID-ANGLE MAGNETIC DETECTOR FOR COLLISION RINGS. Cordier, A. (Ecole Normale Superieure, 91–Orsay (France). Lab. de l'Accelerateur Lineaire). May 1973. 140p. (In French). INIS.

Thesis. Submitted to Paris Univ., Orsay (France).

A type of magnetic detector intended for use in conjunction with the Orsay Collision Rings is presented. A cathodic detection is possible using cylindrical multiwire proportional chambers. The structure and the operating principles of multiwire proportional chambers are presented together with analyses of tests carried out on flat chambers (anode and cathode measurements), these tests having led to the development and conception of the multiwire proportional chambers. Two prototype chambers are described, and their characteristics discussed (anode and cathode supports, cathode mesh). The originality of the chambers developed lies in the small amount of material utilized (10^{-3} times the wavelength of the radiation used per chamber) and in the cathode detection which enables all the coordinates of the positions where the particle traversed to be determined without ambiguity. A total detection over an azimuthal angle of 2π is also possible. Tests effected demonstrated that these detectors are suitable for particle physics experiments. (INIS)

13346 STUDY OF THE HELIUM-JET RECOIL-TRANSPORT METHOD. Kosanke, K. L. East Lansing, MI; University of Michigan (1973). 127p. University Microfilms Order No. 74-6076.

Thesis (Ph. D.).

The Helium-Jet Recoil-transport (HeJRT) system has been studied for the purposes of discovering more of the detail of the mechanism of its operation and to facilitate its further development. The major portion of this thesis is a report of a series of experiments in which the operation of the HeJRT system is defined and in which the effects of varying the operating parameters of the system were recorded. This has provided an experimental basis that has allowed us to make statements on possible mechanisms of operation and the importance of certain features of the system. Of course, also included are a detailed description of the HeJRT system and sections discussing some of the extensions of HeJRT techniques that have resulted, such as those allowing the performance of on-line aqueous chemistry with the system. The initial motivations for the construction of a HeJRT system was its intended use as a subsystem in an on-line mass identification system to be used in conjunction with conventional nuclear counting experiments. Present thoughts on this application are included in the introductory chapter of this thesis. (Diss. Abstr. Int., B)

PHYSICS (ASTROPHYSICS AND COSMOLOGY)

Cosmic Radiation

Refer also to abstracts 12671, 12793, 13795, 14193, and 14221.

13347 THE 1972 COSMIC RAY ELECTRON SPECTRUM ABOVE 0.5 GeV. Burger, J.J.; Swanenburg, B.N. (Cosmic Ray Working Group, Kamerlingh Onnes Laboratorium, Leiden the Netherlands). J. Geophys. Res. 79: No. 10, 1533-1534 (1 Apr 1974).

The cosmic ray electron spectrum above 0.5 GeV has been measured during a special operation of the Ogo 5 satellite from June 30 to July 13, 1972. The results are presented and compared with earlier data provided by the same instrument over the period March 1968 to August 1971. (auth)

13348 A THREE-DIMENSIONAL STUDY OF 30- TO 300-MeV ATMOSPHERIC GAMMA RAYS. Thompson, D.J. (Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). J. Geophys. Res. 79: No. 10, 1309-1320 (1 Apr 1974).

A three-dimensional study of atmospheric gamma rays with energy greater than 30 MeV has been carried out. A knowledge of these atmospheric secondaries has significant applications to the study of cosmic gamma rays. For detectors carried on balloons, atmospherically produced gamma rays are the major source of background. For satellite detectors, atmospheric secondaries provide a calibration source. Experimental results were obtained from four balloon flights from Palestine, Texas, with a 15 cm by 15 cm digitized wire grid spark chamber. The energy spectrum for downward-moving gamma rays steepens with increasing atmospheric depth. Near the top of the atmosphere the spectrum steepens with increasing zenith angle. A new model of atmospheric secondary production has calculated the depth, the energy, and the zenith angle dependence of gamma rays above 30 MeV, using a comprehensive three-dimensional Monte Carlo model of the nucleon-meson-electromagnetic cascade. Results of the calculation agree reasonably well with the experimental data and provide a means of extending the knowledge of atmospheric gamma rays to conditions not covered by the experiments. (auth)

13349 MECHANISM OF THE DIURNAL ANISOTROPY OF COSMIC RADIATION. Kane, R.P. (Physical Research Laboratory, Ahmedabad 380009, India). J. Geophys. Res. 79: No. 10, 1321-1331 (1 Apr 1974).

The observed diurnal vector of cosmic ray neutron intensity at Deep River for the period 1965–1968 is resolved into a radially outward convection vector and a diffusion vector, days of Forbush decreases being omitted. The diffusion vector deviates from the interplanetary field direction by more than 1 hour in 60% of the cases and by more than 2 hours in 35% of the cases. Days of large deviations are studied in detail. On some days the diffusion vector remains along the garden hose direction (as if it had a memory of it) even though the field deviates from the garden hose direction. On some other days the reverse situation is obtained. On some days when the net diffusion is not field aligned, very large perpendicular and/or transverse diffusions are to be involved, implying cosmic ray gradients sometimes as high as 10%/AU or more in the ecliptic plane and/or perpendicular to it. Since there is no experimental evidence for such high gradients, it is suggested that the possibility of other processes as yet undiscovered that could augment the convection-diffusion mechanism should be kept in mind. (auth)

13350 OBSERVATION OF A CELESTIAL HARD X-RAY BURST IN COINCIDENCE WITH A GAMMA-RAY BURST. Palumbo, G.G.C.; Pizzichini, G.; Vespignani, G.R. (Lab.TE.S.R.E./C.N.R., Bologna, Italy). Astrophys. J. Lett. 189: No. 1, L9-L11 (1 Apr 1974).

One of the celestial γ-ray bursts recently discovered by the Vela satellites has been observed in the 27–189 keV energy range by a directional X-ray detector aboard OSO-6, on 1969 October 7. The event has an intensity of about 10^{-4} ergs cm^{-2} in the 50–200 keV energy range. It seems to start earlier but reaches its maximum in correspondence to the Vela time and is located at high northern galactic latitude. The 3 σ positional error box is, in fact, centered at $\alpha = 12^h28^m$, $\delta = +30°$. Possible spectral shapes are also discussed. (auth)

13351 CELESTIAL DIFFUSE GAMMA RADITION ABOVE 30 MeV OBSERVED BY SAS-2. Fichtel, C.E.; Kniffen, D.A.; Hartman, R.C. (Goddard Space Flight Center, Greenbelt, Maryland). Astrophys. J. Lett. 186: No. 3, L99-L104 (15 Dec 1973).

The Small Astronomy Satellite (SAS)-2, launched on 1972 November 15, carried into orbit a 32-deck magnetic-core digitized spark chamber γ-ray telescope to study celestial gamma radiation in the energy range above 30 MeV. In the study of several regions with $|b^{II}| > 15°$, a finite diffuse flux of γ-rays with a steep energy spectrum in the energy region from 35–200 MeV is observed. Representing the energy spectrum by a power law of the form $dJ/dE = AE^{-\alpha}$ over this energy range, α is found to be 2.7 (+0.4, –0.3), and the integral flux above 100 MeV is (2.8 [+0.9, –0.7]) $\times 10^{-5}$ photons (cm^2 sterad s)$^{-1}$. Combining this result with existing low-energy γ-ray data yields an energy spectrum which is not a simple power law in energy as in the X-ray region, but which instead demonstrates first an increase and then a decrease in slope, consistent within uncertainties with that predicted by cosmological theories, including the continuous production of high-energy γ-rays primarily from π^0 mesons throughout the history of the Universe. (auth)

13352 THE SPECTRUM OF GALACTIC ELECTRONS WITH ENERGIES BETWEEN 10 AND 900 GeV. Müller, D.; Meyer, P. (Enrico Fermi Institute). Astrophys. J. 186: No. 3, 841-858 (15 Dec 1973).

A cosmic-ray electron detector has been designed which consists of a counter telescope with 1060 cm^2 sterad geometry factor and a lead scintillator sandwich of about 19 radiation lengths thickness. In order to identify electron showers efficiently, multiple pulse-height analysis of many counters and time-of-flight techniques have been used. This instrument has been exposed during 1970 in three high-altitude balloon flights from Palestine, Texas. The data analysis is based on results from accelerator calibrations with electrons and pions at SLAC. Discrimination against a contamination of the electron data due to interacting protons has been achieved by statistical methods. The resulting differential energy spectrum of cosmic-ray electrons can be well described by a single power law with spectral index 2.66 ± 0.1 up to energies around 250 GeV. Within the experimental uncertainty, no change in this spectral slope up to almost 1000 GeV can be detected. Some implications of these results are discussed. (auth)

13353 THE DIFFUSE X-RAY SPECTRUM FROM 14 TO 200 keV AS MEASURED ON OSO-5. Dennis, B.R.; Suri, A.N.; Frost, K.J. (Solar Plasmas Branch, Laboratory for Solar Physics, NASA-Goddard Space Flight Center, Greenbelt, Maryland). Astrophys. J. 186: No. 1, 97-107 (15 Nov 1973).

The measurement of the energy spectrum of the diffuse component of the cosmic X-ray flux made on the OSO-5 spacecraft is described. The contributions to the total counting rate of the actively shielded X-ray detector are considered in some detail, and the techniques used to eliminate the noncosmic components are described. Positive values for the cosmic flux are obtained in seven energy channels between 14 and 200 keV, and two upper limits are obtained between 200 and 254 keV. The results can be fitted by a power-law spectrum of the form. Flux = $(46 \pm 10)E^{-2.08 \pm 0.2}$ photons (cm^2 s sterad keV)$^{-1}$. A critical comparison is made with the OSO-3 results, with the conclusion being that the reported break in the energy spectrum at 40 keV is possibly produced by an erroneous correction for the radioactivity induced in the detector on each passage through the intense charge-particle fluxes in the South Atlantic Anomaly. If such a break in the spectrum exists at all, it cannot be as sharp or as great a change as that reported by Schwartz et al. (auth)

13354 RESULTS ON THE ENERGY DEPENDENCE OF COSMIC-RAY CHARGE COMPOSITION. Balasubrahmanyan, V.K.; Ormes, J.F. (Goddard Space Flight Center, Greenbelt, Maryland). Astrophys. J. 186: No. 1, 109-122 (15 Nov 1973).

Measurements using a ballon-borne ionization spectrometer on the differential energy spectra of the heavy nuclei of the galactic cosmic radiation are reported. The results include more data and improved charge and energy analysis over our previously reported results. The spectra of individual elements up to oxygen and groups of nuclei up through iron have been measured up to almost 100 GeV per nucleon. The energy spectrum of the secondary nuclei, B + N, is steeper than that of the primary nuclei, C + O, $\Delta\gamma = 0.21 \pm 0.09$ in agreement with Smith et al. The spectral shapes found by us are reasonably well represented by single power laws between 2 and 60 GeV per nucleon. Our data are consistent with the decrease in the secondary-to-primary ratio found by Juliusson et al. above 20 GeV per nucleon, but our data show no evidence for any sudden change in this ratio within counting statistics. The most dramatic finding is that the spectrum of the iron nuclei is flatter than that of the carbon and oxygen nuclei by 0.57 ± 0.14 of a power. The $10 \leq Z \leq 14$ group spectrum is consistent with that of C+O within errors. The experimental techniques for charge and energy determination are presented. Charge resolution is unique through oxygen, and at iron the error is $\pm$ one charge, so the charge groups are clearly separable. Energy is measured with $\sigma = 30$ percent between 2.5 and 25 GeV per nucleon. Corrections due to nuclear disintegration and losses of energy out the bottom of the spectrometer are discussed. (auth)

Stars

Refer also to abstracts 13807, 13866, 14209, and 14495.

13355 DYNAMICAL INSTABILITY IN DENSE HELIUM WHITE DWARFS. Whitman, L. E. New York; New York Univ. (1973). 141p. University Microfilms Order No. 74-1984.

Thesis (Ph. D.).

In response to the discovery of pulsars and their subsequent theoretical identification with (rotating) neutron stars, this thesis was undertaken to clarify one of the ways by which low mass stars might evolve into the highly collapsed states required to explain pulsar behavior. In particular, the dynamical behavior of cold, dense helium white dwarfs near the Chandrasekhar mass limit, 1.4 solar masses, are examined as they are destabilized by a "$\gamma = 4/3$ relativistic effect" and by the onset of inverse beta decay. The periods of oscillation of stable white dwarfs, the central density at which helium white dwarfs become unstable to infinitesimal perturbations, and the e-folding times of the linearly unstable configurations are obtained using standard variational techniques applied to the linearized post-Newtonian relativistic equation of motion. A Fermi gas equation and radial symmetry have been assumed. The results are compared to previous investigations. Variational forms for the fundamental radial modes of the linear oscillations of the white dwarfs are given and their significance discussed. The full set of non-linear partial differential equations describing the time behavior of dense helium white dwarfs are written in finite difference form and their solution obtained computationally. A simplified three-fold zero temperature equation of state (for the degenerate electron region, the inverse beta decay region, and the nuclear matter region) and no neutrino-matter interaction have been assumed. Three ranges of central densities are examined. Linearly stable white dwarfs with central densities less than the relativistic instability point, ρ_{crit}, oscillate about their equilibrium configurations with periods close to that predicted by linear theory. Linearly unstable white dwarfs with central densities above ρ_{crit} but less than the inverse beta decay threshold expand until stable configurations are achieved. Models with central densities above the threshold collapse with heavy shocking down to neutron star configurations. Of more physical interest, perhaps, are the stable white dwarfs near the mass peak which experience accretion (as members of binary systems, for example) and become unstable; statically simulating accretion, collapse down to neutron star states are found. Limits of validity imposed by the zero temperature approximation and the choice of initial composition and density are discussed, the latter from both theoretical and observational points of view. Predictions are compared with the results of current observation, in particular, the lack of short period oscillations of known white dwarfs and the x-ray pulsations of objects like Cen X-3. Possible damping mechanisms are discussed as well. (Diss. Abstr. Int., B)

13356 ENERGY DISTRIBUTION IN SPECTRA OF 19 STARS IN WAVELENGTH REGION OF $\gamma\gamma$5500 TO 9000 A. Komarov, N. S.; Pozigun, V. A.; Dragunova, A. V. Astrometriya Astrofiz.; 19: 98-110(1973). (In Russian).

The energy distribution, E_λ, in the spectra of 19 stars was obtained in the wavelength region of $\lambda\lambda$ 5500 to 9000 Å. The technique for determination of E_λ for the near infrared region of the spectrum is described. The results are given in the units of erg/cm^{2}sec per $\Delta\lambda$ 1 cm. (auth)

13357 SPECTROPHOTOMETRY OF THE PLEIADES STAR CLUSTER. I. Continuous Spectrum. Vykhrestyuk, T. P.; Karetniko, V. G. Astrometriya Astrofiz.; 19: 110-118(1973). (In Russian).

From spectrograms with a dispersion of 166 Å/mm at H_γ energy distributions in the spectrum (erg/cm^{2}sec), spectrophotometric gradients and Balmer's discontinuity were calculated in 44 Pleiades cluster stars. The comparison made of the data with "normal" magnitudes of gradients permitted the clusters to be divided into reddened and non-reddened stars after determining the characteristics of light absorption. Most of the stars showed no anomalies in the continuous spectrum. (auth)

13358 MODIFICATION OF THE LAFLER-KINMAN-KHOLOPOV METHOD FOR DETERMINING THE CHANGE PERIOD OF VARIABLE STAR LIGHT BRIGHTNESS. Grigorevskii, V. M.; Vykhrestyuk, S. S.; Belotserkovskii, B. E.; Petrov, M. P.; Ivanov, V. N. Astrometriya Astrofiz.; 19: 118-127(1973). (In Russian).

A modification of the Lafler-Kinman-Kholopov method is proposed which makes it possible to reduce markedly the time taken for computations at the second stage and subsequent ones of determining the period of light change. The computations made for the star CV8 2550 showed that the period improvement takes about three times less machine time than it does in the original method. It is shown that the modified method may be successfully used for the light change curves of the Earth satellites as well. (auth)

13359 THEORY OF THERMAL RUNAWAY IN HYDROGEN ENVELOPE OF WHITE DWARF. Redkoborodyi, Yu. N. Astrometriya Astrofiz.; 17: 3-28(1972). (In Russian).

An evolutionary sequence was calculated for a white dwarf on which a hydrogen rich envelope in assumed to increase with time. The stellar models were computed by integrating numerically the system of stellar structure equations by means of the Henyey method. The accretion of matter was assumed to be quasi-static. Near the point of the chemical discontinuity a temperature maximum is shown to arise, then hydrogen ignites, a thin shell energy source being formed. The new shell source is thermally unstable. The resulting thermal runaway was investigated numerically and by means of a simple approximation based on the energy balance in the hydrogen burning shell source. (auth)

13360 CLASSIFICATION OF STARS BY UNWIDENED LOW-DISPERSION SPECTRA. III. Technique and Criteria of Classification. Voroshilov, V. I.; Kalandadze, N. B.; Kuznetsov, V. I. Astrometriya Astrofiz.; 15: 15-22(1972). (In Russian).

A technique and system of criteria were worked out for classification of spectra obtained with a 4° prism attached to the Abastumani 70 cm Maksutov telescope. The classification was carried out by means of microphotometer tracings of unwidened spectra on the basis of central line depth ratios. Accuracy of the classification is about three subclasses. The technique makes it possible to carry out the MK classification up to B-magnitude 15m. (auth)

13361 CLASSIFICATION OF STARS UNWIDENED LOW-DISPERSION SPECTRA. IV. Catalog of Spectra of Faint Stars Around NGC 2129. Kuznetsov, V. I. Astrometriya Astrofiz.; 15: 22-26(1972). (In Russian).

Spectral classification of faint stars in the region of a square degree around NGC 2129 is extended up to 15.0m. The unwidened low-dispersion (666Å/mm near H_γ) spectra were used to obtain 337 spectra. (auth)

13362 DETERMINATION OF VIBRATIONAL TEMPERATURE OF THE STARS DELTA Lyr AND α Her A FROM SPECTRAL BANDS OF THE TiO α-SYSTEM. Shavrina, A. V. Astrometriya Astrofiz.; 15: 37-39(1972). (In Russian).

Vibrational temperatures for δ^1 Lyr and α Her A were determined by means of band intensities of the TiO molecule α-system. These values of the temperature were compared with those obtained by band intensity measurements of the TiO γ-system. (auth)

13363 INVESTIGATION OF VARIABLES WR-96, GR-29, AND WR-96(2). Koval'chuk, G. Y. Astrometriya Astrofiz.; 15: 39-46(1972). (In Russian).

m_{pg} and m_{pv} magnitudes for three variables were obtained from the plates of sky survey at the Main Astronomical Observatory of the Ukrainian Academy of Sciences. Variability of WR-96 (2) was detected for the first time. Distribution functions of brightness are considered. (auth)

13364 PHOTOGRAPHIC OBSERVATIONS OF VARIABLE STARS IN THE VICINITY OF NGC 6830. Shaganian, B. L. Astrometriya Astrofiz.; 15: 46-55(1972). (In Russian).

Photographic observations of stars OW, OR, V 433, V 768, and V 1086 Aquilae are given. Brightness of these stars was estimated in the plates of the Sternberg Institute. New elements are obtained for OW and V 1086 Aql. Cycles of light changes in OR Aql are determined more accurately. V 433 Aql is found to have two cycles of oscillations. Charts of the variables, photographic magnitudes of comparison stars, and epochs of light maxima are given. Photographic light curves are obtained. (auth)

13365 NATURAL MOTION OF 122 ECLIPSING VARIABLE STARS. Volynskaya, M. Yu. Astrometriya Astrofiz.; 15: 96-100(1972). (In Russian).

On the basis of star positions from the author's catalog and numerous other meridian and photographic catalogs, natural motions were determined for 102 eclipsing variable stars and improved for 20 stars. Components of natural motions $\mu_\alpha\cos\delta$ and $\mu\delta$ are given in the GC system, probable determination errors are presented. (auth)

13366 SELF-CONSISTENT SOLUTION FOR AN AXISYMMETRIC PULSAR MODEL. Kuo-Petravic, L.G. (Atlas Computer Laboratory, Chilton, Didcot, Berkshire, England and St. Hilda's College, Oxford, England); Petravic, M.; Roberts, K.V. Phys. Rev. Lett. 32: No. 18, 1019-1022 (6 May 1974).

A spinning neutron star surrounded by a magnetosphere is widely accepted as the basic pulsar model. We have obtained a self-consistent numerical solution for the case when the rotation and magnetic axes are aligned. The field lines close even beyond the light radius R_L, and with Crab-pulsar parameters 5×10^{37} erg/sec are carried away by relativistic particles. An equatorial region of high-energy density is found near R_L which could be the region of observed radio emission. (auth)

13367 BEAT FREQUENCY OSCILLATIONS NEAR CHARGED BLACK HOLES AND OTHER ELECTROVACUUM GEOMETRIES. Gerlach, U.H. (Department of Mathematics, The Ohio State University,

Columbus, Ohio 43210). Phys. Rev. Lett. 32: No. 18, 1023-1025 (6 May 1974).

Near a charged black hole (or any other space-time permeated by a steady electromagnetic field) an electromagnetic mode oscillates in sympathy with a suitably polarized gravitational mode (and conversely). Two co-traveling modes beat against each other, exchanging totally and periodically their common energy along their history near the black hole. The black hole serves therefore as a catalyst for converting electromagnetic into gravitational radiation. Thus the effective coupling of charged matter with gravitational radiation is of the same order of magnitude as with electromagnetic radiation. (auth)

13368 MANY-BODY CLUSTERS IN A DENSE STRONGLY INTERACTING QUANTUM LIQUID AT 0°K. Rajaraman, R. (Department of Physics, University of Delhi, Delhi 7, India). Phys. Rev. A 9: No. 6, 2761-2772 (June 1974).

A beginning is made towards solving for the energy of dense and strongly interacting quantum liquids at 0°K, starting all the way from the interparticle potential. Liquids He^3 and He^4 as well as neutron-star interiors approximate such a system. Since expansions do not converge either in powers of the interaction or in the density, n-body clusters have to be calculated for all n and to all orders in the potential. Working within a simplified model, a method is suggested for estimating n-body contributions to the binding energy. The method is far simpler than more direct methods thus far employed, which can be used only for low values of n. This is verified and illustrated by comparison with these existing calculations of two-, three-, and four-body energies. A discussion is also given of the steps remaining to be taken where this paper leaves off. Possible "pairing" and "super" properties are outside the scope of this paper. (auth)

13369 CRYSTALLIZATION OF DENSE NEUTRON MATTER. Canuto, V. (Institute for Space Studies, Goddard Institute for Space Studies, NASA, New York, New York 10025); Chitre, S.M. Phys. Rev. D 9: No. 6, 1587-1613 (15 Mar 1974).

The equation of state for cold neutron matter at high density is studied in the t-matrix formulation and it is shown that energetically it is convenient to have neutrons in a crystalline configuration rather than in a liquid state for values of the density exceeding 1.6×10^{15} g/cm³. The study of the mechanical properties indicates that the system is stable against shearing stresses. A solid core in the deep interior of heavy neutron stars appears to offer the most plausible explanation of speed-ups observed in the Vela pulsar. (auth)

13370 SPECTROPHOTOMETRIC OBSERVATIONS OF A HIGHLY ABSORBED OBJECT IN CYGNUS. Merrill, K.N.; Soifer, B.T. (University of California, San Diego, Department of Physics). Astrophys. J. Lett. 189: No. 1, L27-L30 (1 Apr 1974).

Spectrophotometric observations from 2.8 to 14 μ with resolution $\Delta\lambda/\lambda\sim0.015$ are reported for an object (AFCRL No. 809-2992) found in the AFCRL infrared sky survey. Significant absorption is found at 3.1 μ and in a very broad feature at ~10 μ. The 3.1-μ feature is attributed to absorption by ice, while the 10-μ feature is fitted well with an absorption profile defined by the emission spectrum of the Trapezium. (auth)

13371 SOME OBSERVATIONAL IMPLICATIONS OF EXTENDED STATIC O-STAR MODEL ATMOSPHERES. Mihalas, D. (High Altitude Observatory, National Center for Atmospheric Research, Boulder, Colorado 80302); Hummer, D.G. Astrophys. J. Lett. 189: No. 1, L39-L43 (1 Apr 1974).

Some results and observational implications are presented for the first extended spherical non-LTE model atmospheres in hydrostatic and radiative equilibrium. These models all correspond to a star with $M=60M_\odot$, $L=1.25\times10^6\ L_\odot$, and $R=24\ R_\odot$, with an effective temperature $T_{\text{eff}}\simeq39{,}500$°K and surface gravity log $g\simeq3.45$ (spectral type near O6). They are differentiated by the magnitude and radial dependence of a radiation-force multiplier γ, inserted into the equation of hydrostatic equilibrium, to simulate the effect of radiation force on opacity sources (e.g., lines) that have not been included in the calculations. It has been possible to obtain models very close to the limit at which the radiation force balances the gravity. Hydrogen and helium (Y=0.1) constitute the gas; six hydrogen lines are treated explicitly. These models show Lα in emission, the lower Balmer lines in absorption, the Balmer jump in absorption, and both infrared and ultraviolet excesses relative to the visual. Continuum jumps and gradients, Strömgren-system colors, and equivalent widths of Hα, Hβ, and Hγ are tabulated and discussed briefly. (auth)

13372 MULTIPLE STAR SYSTEMS AND X-RAY SOURCES. Bahcall, J.N.; Dyson, F.J.; Katz, J.I. (Institute for Advanced Study, Princeton, New Jersey); Paczyński, B. Astrophys. J. Lett. 189: No. 1, L17-L18 (1 Apr 1974).

Two classes of triple-star models are proposed which allow X-ray sources of the type of Cygnus X-1 to be interpreted without invoking a black hole. The large mass which is usually assigned to the X-ray source Cyg X-1 belongs in the models to a normal star. (auth)

13373 THE GALACTIC ORBIT OF THE OLD OPEN CLUSTER NGC 2420. Keenan, D.W.; Innanen, K.A. (Physics Department and Centre for Research in Experimental Space Science, York University, Downsview, Ontario). Astrophys. J. 189: No. 2, 205-207 (15 Apr 1974).

The galactic orbit of NGC 2420 has been computed in three different mass models of the Galaxy. Among other possible explanations, its eccentric orbit and age may possibly be reconciled as the result of a gravitational perturbation by an encounter with one of the Magellanic Clouds. (auth)

13374 SENSITIVITY OF THE STAR FORMATION RATE TO THE INTERSTELLAR GAS ABUNDANCE OF HEAVY ELEMENTS. Talbot, R.J. Jr. (Institute of Astronomy, Cambridge, England). Astrophys. J. 189: No. 2, 209-215 (15 Apr 1974).

The critical pressure required to produce the thermal instability in the interstellar gas is approximately inversely proportional to the heavy-element abundance. A model for the rate of star formation is presented which is based upon this relationship plus the assumption that star formation accompanies the formation of interstellar gas clouds of high density. This physical model is equivalent to the model of metal-enhanced star formation hypothesized by Talbot and Arnett to explain the paucity of stars with low metal abundance. The model presented here is shown to agree with the following observations: the mass fraction remaining in the form of interstellar gas; the U, Th, Re, Os, Pu, and I radioactive chronologies; the metal abundance of disk stars formed throughout the Galaxy's history, including spatial variations at a given epoch; the efficiency of star formation; and both a mass-to-light ratio and a supernova rate which are compatible with those of the Galaxy. The rate of star formation per unit area of the disk varies with the areal density of the interstellar gas in such a way as to simulate a power law with an exponent of 1.7 to 2.3. The scale height of disk stars decreases with time in a manner consistent with observations. (auth)

13375 SELECTED LINE IDENTIFICATIONS IN THE ULTRAVIOLET SPECTRUM OF GAMMA EQUULEI. Adelman, S.J. (NASA, Goddard Space Flight Center, Greenbelt, Maryland). Astrophys. J. Suppl. Ser. 27: No. 242, 183-201 (Mar 1974).

Selected line identifications for the cool Ap star γ Equ in the region λλ3093-3806 are given. Atomic species of importance include Co II, Ni II, Nb II, Mo II, Rh I, Pd I, Ce III, Pr III, Nd III, Sm III, Tb II, Dy II, Ho II, Er II, Tm II, and Yb II. Some implications of their identifications are discussed. (auth)

13376 THE PECULIAR A STAR HD 215441. Adelman, S.J. (NASA, Goddard Space flight center, Greenbelt, Maryland). Astrophys. J. Suppl. Ser. 27: No. 242, 203-245 (Mar 1974).

Line identifications are given for the sharp-lined strong magnetic Ap star HD 215441 in the spectral region λλ3638-4644 near magnetic maximum. Lines of Cl II and Ti III were found in addition to those of atomic species previously identified. Comparison of the spectrum with those of normal B and other hot magnetic Ap stars shows that this star shares the anomalies of other silicon stars. The derived magnetic field strength does not depend on a line's stage of ionization, excitation potential, or wavelength, but rather is the same for lines of all atomic species. Thus the magnetic field strength is not a function of physical depth in the line-forming regions of the atmosphere of HD 215441. Furthermore, the σ- and σ+ components of the Zeeman patterns lie symmetrically about the π components for the lines studied, although different broadening functions affect the various components. (auth)

13377 POST-NEWTONIAN NEUTRON STARS. Wagoner, R.V. (Institute of Theoretical Physics, Department of Physics, Stanford University, Stanford, California 94305); Malone, R.C. Astrophys. J. Lett. 189: No. 2, L75-L78 (15 Apr 1974).

Models of neutron stars are constructed within the framework of the parametrized post-Newtonian approximation of metric theories of gravity. It is found that the observed masses of both the neutron star and the ordinary star in a binary system can differ considerably from the general-relativistic predictions. (auth)

13378 ON THE LINEAR POLARIZATION OF GD 229. Kemp, J.C. (Department of Physics, University of Oregon, Eugene, Oregon, 97403); Coyne, G.V.; Swedlund, J.B.; Wolstencroft, R.D. Astrophys. J. Lett. 189: No. 2, L79-L80 (15 Apr 1974).

The linear polarization of the peculiar white-dwarf suspect GD 229 has been defined more carefully as $p=(3.2\pm0.8)$ percent, $\theta=80°\pm5°$, in the blue to visible, with little apparent variability. The position angle agrees roughly with the mean for the red polarization, although the latter was observed to vary. (auth)

13379 RADIO EMISSION FROM PRE-MAIN-SEQUENCE STARS. Spencer, J.H.; Schwartz, P.R. (E. O. Hulburt Center for Space Research, Naval Research Laboratory, Washington, D.C. 20375). Astrophys. J. Lett. 188: No. 3, L105-L106 (15 Mar 1974).

Thermal radio emission has been detected from circumstellar nebulae of the pre-main-sequence stars T Tauri and LkHα-101. The radio sources have angular size of less than 1".0. (auth)

13380 PHOTOELECTRIC PROFILE MEASUREMENTS OF Hα AND Hβ IN Be STARS. Gray, D.F.; Marlborough, J.M.

(Department of Astronomy, University of Western Ontario, London). Astrophys. J. Suppl. Ser. 27: No. 240, 121-130 (Mar 1974).

We present photoelectric measurements of Hα and Hβ in 14 Be stars. We find from a shape analysis of the wings of Hα that a Gaussian broadening mechanism is reasonable whereas a damping profile is not. It is suggested on this basis that the width and shape of Hα can be reasonably interpreted as a combination of shell rotation and electron scattering. (auth)

13381 THE MASS OF THE GLOBULAR CLUSTER NGC 6388. Illingworth, G.; Freeman, K.C. (Mount Stromlo and Siding Spring Observatory, Research School of Physical Sciences, Australian National University). Astrophys. J. Lett. 188: No. 3, L83-L86 (15 Mar 1974).

The central velocity dispersion has been derived for the globular cluster NGC 6388 from high-dispersion coudé spectra of the integrated light. A new method using Fourier techniques for accurately determining the velocity dispersion from integrated light spectra is described. The mass was obtained from King's models, using photoelectric surface photometry and star counts to define the surface density distribution. The resulting mass is $(1.3\pm0.3)\times10^6$ $M_\odot$, and the mass-luminosity ratio $(M/L_v) = 1.7\pm0.4$ solar units. (auth)

13382 ON THE NUMBERS, BIRTHRATES, AND FINAL STATES OF MODERATE- AND HIGH-MASS STARS. Ostriker, J.P.; Richstone, D.O.; Thuan, T.X. (Princeton University Observatory). Astrophys. J. Lett. 188: No. 3, L87-L89 (15 Mar 1974).

Using counts of stars in the solar neighborhood and conventional stellar-lifetime calculations, we find death rates of stars in the mass ranges $(4 \leq M/M_\odot \leq 8)$ and $(8 < M/M_\odot)$ to be 3.6×10^{-11} and 1.1×10^{-11} yr^{-1} pc^{-3}, respectively. If the moderate-mass stars each ejected 1.4 $M_\odot$ of iron peak elements at death and if the heavy stars each produced a neutron-star pulsar, then the calculated pulsar birthrate would be a factor 5 smaller than the "observed" rate 5×10^{-11} pc^{-3} yr^{-1}. Also, the local iron abundance would be larger by a factor $6<B>/B(T)$ than the observed value 1.4×10^{-3}. Since the ratio of the average to the present birthrate of moderate-mass stars, $<B>/B(T)$, is of order 10^4, the discrepancy is a factor of 60 and probably so large as to preclude the possibility that 4-8 $M_\odot$ stars eject iron cores. The statistical agruments are quite consistent with the suggestion by Arnett and Schramm that, while the iron cores of high-mass stars implode, the outer portions explode, providing the principal means of nuclear processing in the Galaxy. (auth)

13383 SOLID PARTICLES AND STELLAR MASS LOSS. Fix, J.D. (Department of Physics and Astronomy, University of Iowa, Iowa City, Iowa 52242); Alexander, D.R. Astrophys. J. Lett. 188: No. 3, L91-L92 (15 Mar 1974).

Extensive model atmosphere calculations for cool giants and supergiants show that solid particles do not cause mass loss in such stars. (auth)

13384 HIGH-SPECTRAL-RESOLUTION MEASUREMENTS OF THE H I λ1216 AND Mg II λ2800 EMISSIONS FROM ARCTURUS. Moos, H.W. (Department of Physics, The Johns Hopkins University, Baltimore, Maryland 21218); Linsky, J.L.; Henry, R.C.; McClintock, W. Astrophys. J. Lett. 188: No. 3, L93-L95 (15 Mar 1974).

High-spectral-resolution scans of H I λ1216 and Mg II λλ2796, 2803 obtained using the ultraviolet spectrometer abroad the Copernicus satellite show broad and very asymmetrical emission profiles. The ratio of the line widths to the solar values is consistent with a law similar to the Wilson-Bappu relation for the calcium K reversal. A fit of the interstellar absorption profile indicates that the average H density toward this nearby star is low, 0.02-0.1 cm^{-3} (auth)

13385 ULTRAVIOLET DETECTION OF THE NOVA VARIABLES V603 AQUILAE AND RR PICTORIS. Gallagher, J.S. (Behlen Laboratory of Physics, University of Nebraska-Lincoln); Holm, A.V. Astrophys. J. Lett. 189: No. 3, L123-L126 (1 May 1974).

During the lifetime of the OAO-2, ultraviolet photometric observations of the old novae V603 Aql, T crB, DQ Her, Rs Oph, RR Pic, and FH Ser were attempted. Only V603 Aql and RR Pic were positively measured; and by comparing ultraviolet colors of the novae with those of normal stars we are able to deduce color temperatures of 25,000° and in excess of 35,000°K, respectively. Interpretation of the ultraviolet energy distributions is complicated by the possible presence of extended envelopes. We therefore cannot find a unique luminosity from the data but are able to estimate the minimum bolometric luminosity to be about 10 $L_\odot$ for both stars. The two observations of RR Pic indicated that the star varied by 0.5 mag during a time interval of 1.7 hours while the relative continuum energy distribution remained unchanged; V603 Aql was not observed to be variable. (auth)

13386 HIGH-RESOLUTION MAPS OF THE KLEINMANN-LOW NEBULA IN ORION. Rieke, G.H.; Low, F.J. (Lunar and Planetary Laboratory and Steward Observatory, University of Arizona, Tucson); Kleinmann, D.E. Astrophys. J. Lett. 186: No. 1, L7-L11 (15 Nov 1973).

The Kleinmann-Low nebula has been mapped at 5, 10.5, and 21 μ with angular resolution ranging from 2″ to 7″. The core of the nebula is resolved into four compact sources in addition to the Becklin-Neugebauer object. (auth)

13387 A NEW ANALYSIS OF THE A $^2\Delta$-X $^2\Pi$ SYSTEM OF CH. Krupp, B.M. (Astronomy Program, University of Maryland). Astrophys. J. 189: No. 2, 389-397 (15 Apr 1974).

A more precise formula of the Hill and Van Vleck type is developed for the rotational levels of the components of doublet states in diatomic molecules. An additional rotational constant H_v is accurately included in the development. New values of the molecular constants of the A $^2\Delta$-X $^2\Pi$ system of CH are obtained using the smoothed data of Gerö and of Kiess and Broida. The spin-coupling constants Y_v of both states are found to vary with the rotational quantum number. (auth)

13388 ACCRETION ONTO BLACK HOLES: THE EMERGENT RADIATION SPECTRUM. III. ROTATING (KERR) BLACK HOLES. Shapiro, S.L. (Princeton University Observatory). Astrophys. J. 189: No. 2, 343-351 (15 Apr 1974).

Steady-state, spherically symmetric accretion of matter onto rotating black holes is examined for simple polytropic gases. The total luminosity and frequency spectrum of the radiation emitted by interstellar hydrogen accreting onto a rotating black hole and observed above 1 keV are computed. It is found that for the same interstellar conditions and mass of the central hole, the total luminosity increases as the angular momentum of the black hole increases. Spherical accretion onto a maximally rotating black hole with a=m produces 15.3 percent more energy in the form of hard X-rays and γ-rays than accretion onto a nonrotating black hole. (auth)

13389 THE COALSACK. III. A SEARCH FOR T TAURI STARS. Weaver, W.B. (Warner and Swasey Observatory, Case Western Reserve University). Astrophys. J. 189: No. 2, 263-267 (15 Apr 1974).

Stars found to have Hα emission in the Coalsack on objective-prism plates were examined with photographic $UBVI_{kc}$ photometry and blue objective-prism plates in order to confirm the presence of a T Tauri association suggested by Pik-Sin The. This association was not confirmed. (auth)

13390 SOME MORPHOLOGICAL PROPERTIES OF WN SPECTRA. Walborn, N.R. (David Dunlap Observatory, University of Toronto, Richmond Hill, Ontario, Canada). Astrophys. J. 189: No. 2, 269-271 (15 Apr 1974).

An extension of the Hiltner-Schild line-width classification for WN spectra is introduced, in order to describe more fully the range of line widths among these stars. A simplified excitation classification, based solely upon the relative strengths of N III, IV, and V emission features in the classification region, is used. The mutual independence of excitation, emission-line width, and emission-line strength in WN spectra is emphasized, with reference to an illustration of wide, 62 Å mm^{-1} spectrograms of six southern WN stars. Particular attention is called to the comparison between HD 86161 and 96548, which have nearly identical excitation and line strengths but systematically different line widths. (auth)

13391 THE EFFECT OF SPHERICITY ON STELLAR CONTINUOUS ENERGY DISTRIBUTIONS. Castor, J.I. (Joint Institute for Laboratory Astrophysics, University of Colorado and National Bureau of Standards, Boulder, Colorado 80302). Astrophys. J. 189: No. 2, 273-283 (15 Apr 1974).

Model stellar atmospheres are constructed with the object of explaining the anomaly observed in a number of Wolf-Rayet stars, especially HD 50896, and in at least one Of star, ζ Puppis, that the line spectrum indicates a higher temperature than does the continuous spectrum. The models assume radiative and hydrostatic equilibrium, and local thermodynamic equilibrium. The composition is approximated by pure hydrogen, and the effects of lines are ignored. The spherical symmetry of the atmosphere is taken fully into account. It is found that the extension of the atmosphere, and the atmospheric density, depend critically upon the ratio of luminosity to mass for the model. Approximate analytic results are obtained which give a quantitative expression for this dependence. The principal result regarding the continuous spectrum is that, for the extended models, the brightness temperature is a monotonically increasing function of frequency, over the observed range, which agrees with the effective temperature near the blackbody maximum. This result is explained in terms of the effect of electron scattering on the emergent radiation. The frequency dependence of the brightness temperature is sufficient to explain the observations of ζ Pup if a sufficiently luminous model is chosen. Such models are excluded, however, by stellar evolution theory. It is suggested that an extension of the atmosphere similar to that in luminous models may be produced by a stellar wind, but in order to affect the continuous spectrum the rate of mass loss must be much greater than that obtained by Lucy and Solomon. (auth)

13392 SHORT-PERIOD RADIAL-VELOCITY VARIATIONS IN ν AquarII. Ringuelet, A.E. (Observatorio Astronomico de La Plata,

Argentina); Machado, M.E. Astrophys. J. 189: No. 2, 285-288 (15 Apr 1974).

The central star in π Aquarii. BO Ve, undergoes short-period radial-velocity variations with a period of 0.087 days. (auth)

13393 DO HELIUM-SHELL FLASHES CAUSE EXTENSIVE MIXING IN LOW-MASS STARS? Sweigart, A.V. (Yale University Observatory, New Haven, Connecticut). Astrophys. J. 189: No. 2, 289-291 (15 Apr 1974).

The effects due to the mixing of hydrogen into the convective zone produced by a helium-shell flash have been investigated for a 0.7 $M_\odot$ Population II star. Hydrogen mixing at the maximum rate found by Schwarzschild and Härm does not extend the flash convective zone, since the energy released by the hydrogen burning is almost entirely absorbed by a mild increase in the expansion rate of the intershell region. A substantially greater rate of hydrogen mixing may lead to a splitting of the flash convective zone into two separate convective regions. A deep penetration of the envelope convection does not occur. Extensive mixing seems unlikely during the evolutionary phase considered here. (auth)

13394 A COMPARISON OF VARIABLE AND NONVARIABLE STARS IN THE CEPHEID STRIP. Schmidt, E.G. (Royal Greenwich Observatory, Herstmonceux Castle, Hailsham, Sussex); Rosendhal, J.D.; Jewsbury, C.P. Astrophys. J. 189: No. 2, 293-302 (15 Apr 1974).

Spectra of three Cepheids (RX Aur, X Cyg, and T Mon) and 11 nonvariable supergiants are analyzed. Additional evidence is presented for the presence of nonvariables within the Cepheid strip. Temperatures determined from Hα line profiles and broad-band photometry were used together with model atmospheres and line strengths from the spectra to determine the gravities, turbulent velocities, and element abundances. The gravities of the Cepheids appear to be lower than for the nonvariables at the same luminosity while the turbulent velocities are higher. No differences of significance are found in the element abundances. The gravity differences can be explained either in terms of mass loss in the Cepheids or very low helium abundance in the nonvariables. The former interpretation fails to explain why some Cepheid-strip stars do not vary while the latter raises problems in connection with the origin of the elements. If we assume that pulsation causes some mass loss, a more consistent picture emerges in which only moderate helium deficiencies are required in the nonvariables. (auth)

13395 ULTRAVIOLET PHOTOMETRY FROM THE ORBITING ASTRONOMICAL OBSERVATORY. X. NOVA FH SERPENTIS 1970. Gallagher, J.S. III; Code, A.D. (Space Astronomy Laboratory, Washburn Observatory, University of Wisconsin, Madison). Astrophys. J. 189: No. 2, 303-314 (15 Apr 1974).

Results of ultraviolet filter photometry between 1430 and 4250 Å and low-resolution spectral scans in the wavelength region 2500-3600 Å obtained with the Wisconsin package on the OAO-A2 are reported for Nova FH Serpentis 1970. The observations were made over an interval of 53 days commencing at about the time of maximum visible light. Photometry measurements show the nova became progressively bluer during the early decline of the visual light curve; near maximum no signal was detectable shortward of 2460 Å but 45 days later measurements were obtained at all wavelengths. The photometry data are corrected for extinction by estimating $E(B-V) \simeq 0.8$ and applying a representative ultraviolet extinction curve. With this correction the wavelength of maximum emission moves from longward of 5000 Å at visual maximum to shortward of 2000 Å by the end of the observations. The total flux as estimated from the corrected photometry and a V light curve remains constant to within a factor of 2; based on an estimated distance of 650 pc, the total measured optical luminosity is at least 3×10^{44} ergs and the corresponding average luminosity about $2\times10^4 L_\odot$. Spectral scans with a resolution of 20 Å confirm the conclusions drawn from the photometry. The observed spectrum is dominated by emission from Mg II λ2800 and by what are probably emission complexes due to Fe II. (auth)

13396 HIGH-FREQUENCY STELLAR OSCILLATIONS. X. THE RAPID BLUE VARIABLE CD −42°14462. Hesser, J.E.; Lasker, B.M.; Osmer, P.S. (Cerro Tololo Inter-American Observatory). Astrophys. J. 189: No. 2, 315-318 (15 Apr 1974).

The spectrally peculiar degenerate blue variable DC −42°14462 is both a coherent high-frequency variable, with periods of 29.08 and 30.15 s and mean amplitudes 0.00028 mag, and an erratic low-frequency variable. Variable Hα emission and Hβ and Hγ absorption lines are observed; continuum colors place CD −42°14462 near the 12,000° K blackbody line. The observations can be interpreted as g-mode oscillations on one member of a white-dwarf binary system. (auth)

13397 THE SECONDARY COMPONENT OF BETA LYRAE. Wilson, R.E. (Goddard Institute for Space Studies, New York, New York). Astrophys. J. 189: No. 2, 319-329 (15 Apr 1974).

Qunatitative analysis of β Lyr light curves shows that thin-disk and "no-disk" models for the secondary can be ruled out, leaving (presumably) only a thick-disk model. Some common assertions about the asymmetry and repetition of the light curves are not supported by examination of the existing observations. There is no evidence that the secondary component is underluminous for its mass, provided the observations are interpreted in terms of a thick secondary disk, most of whose luminosity emerges at the poles. The polar effective temperature of the disk is several thousand degrees K higher than that of the primary component, and is therefore the obvious candidate for the elusive source of excitation for the B2-B5 shell spectrum. Because the secondary is not underluminous, there is, at present, no reason to postulate the presence of a collapsed star at its center. Reasons are given to explain why the secondary spectrum has not been seen, despite the fact that the observed continuum flux from the secondary is of the order of one-half that from the primary. Estimates of this flux in previous work were much lower. The mass ratio, M_2/M_1 is estimated to be 4.2(+3.0, −1.8) if the chemical abundances found by Boyarchuk are adopted, or about 6, with similar uncertainty, if abundances by Hack and Job are used. It is argued that the disk must be in strongly differential rotation. Future work on modeling the system might well assume the basic semitoroidal geometry of the Bodenheimer-Ostriker differentially rotating model stars. Most of the secondary mass probably lies in an embedded main-sequence star, rather than in the disk, which is probably of the order of one, or perhaps a few, solar masses. (auth)

13398 A STRONG 350-MICRON SOURCE IN THE OPHIUCHUS DARK CLOUD. Simon, M.; Righini, G.; Joyce, R.R.; Gezari, D.Y. (Department of Earth and Space Sciences, State University of New York, Stony Brook). Astrophys. J. Lett. 186: No. 3, L127-L130 (15 Dec 1973).

A very strong and extended far-infared source has been detected in the Ophiuchus dark cloud in the region of strong molecular emission discovered by Encrenaz. The far-infrared molecular source is apparently the central condensation of the cloud, and is also the region where Grasdalen et al. have found evidence of very recent star formation. This source appears to be very similar to the far-infared molecular source in Orion. (auth)

13399 INFRARED EXCESSES IN THE M SUPERGIANTS OF h AND χ PERSEI. Cohen, M.; Gaustad, J.E. (Astronomy Department, University of California, Berkeley). Astrophys. J. Lett. 186: No. 3, L131-L136 (15 Dec 1973).

Infrared photometry from 3 to 18 microns has been obtained of the M supergiants in the young association h and χ Persei. A color excess indicative of silicate dust is observed for all stars, which correlates with higher luminosity and lower surface temperature. (auth)

13400 IMPLICATIONS OF THE COPERNICUS OBSERVATIONS OF UNREDDENED STARS. Weisheit, J.C.; Tarter, C.B. (University of California, Lawrence Livermore Laboratory). Astrophys. J. Lett. 186: No. 1, L33-L36 (15 Nov 1973).

A variety of simple models for the absorbing gas between λ Sco and the Earth are analyzed in order to interpret the OAO observations of interstellar absorption lines. Our calculations show that the data cannot be reconciled with either the cosmic-ray or X-ray steady-state ionization models of the interstellar medium, and that material in an H II/H I region surrounding λ Sco probably provides the dominant contribution to the lines. (auth)

13401 RADIATION FROM COMETS NEAR NEUTRON STARS. Harwit, M.; Salpeter, E.E. (Center for Radiophysics and Space Research, Cornell University, Ithaca, New York). Astrophys. J. Lett. 186: No. 1, L37-L39 (15 Nov 1973).

Old galactic neutron stars may be orbited by a cloud of comets, and a comet may occasionally fall onto the surface of a neutron star. Although the average infall is less than the accretion rate from interstellar matter, the comet events could lead to γ-ray bursts such as those recently detected. Some X-ray emission is also predicted. (auth)

13402 THREE-COLOR PHOTOMETRY OF THE FLARE STAR EV LACERTAE. Flesch, T.R.; Oliver, J.P. (Department of Physics and Astronomy, University of Florida). Astrophys. J. Lett. 189: No. 3, L127-L129 (1 May 1974).

Four flares have been observed during simultaneous monitoring in the u, b, and r wavelength regions. One event shows substantial dips in the r below the quiescent level of the star; this same event is markedly deficient in u light. It is possible, but not likely, that these dips result from inverse Compton scattering. (auth)

13403 A NEW LIST OF 32 DEGENERATE STARS. VII. Greenstein, J.L. (Hale Observatories, California Institute of Technology, Carnegie Institution of Washington). Astrophys. J. Lett. 189: No. 3, L131-L133 (1 May 1974).

Conclusion of observations with the prime-focus spectrograph of the Hale reflector leads to a list of 20 white dwarfs confirmed spectroscopically. An additional 32 white and yellow degenerates are included in another table; these stars were observed with the multichannel spectrophotometer. Degenerate stars are recognized by narrow-band colors, and by hydrogen and helium lines. Some 10 stars are classified as free of lines, DC, or are known to be circularly polarized. (auth)

13404 DIFFERENCES BETWEEN THE EVOLUTIONARY TRACKS OF YOUNG STARS IN THE GALAXY AND IN THE

MAGELLANIC CLOUDS. Hagen, G.L.; van den Bergh, S. (David Dunlap Observatory, University of Toronto, Richmond Hill, Ontario, Canada). Astrophys. J. Lett. 189: No. 3, L103-L104 (1 May 1974).

The evolutionary tracks of massive young stars in the Galaxy are found to differ systematically from those of similar stars in the Small Magellanic Cloud. Evolving stars in the Large Cloud have charateristics that are intermediate between those of objects in the Galaxy and in the Small Cloud. (auth)

13405 SPECTROSCOPIC OBSERVATIONS OF HZ HERCULIS. II. Bopp, B.W.; Grupsmith, G.; McMillan, R.S.; Vanden Bout, P.A.; Wootten, H.A. (University of Texas at Austin). Astrophys. J. Lett. 186: No. 3, L123-L126 (15 Dec 1973).

Further spectroscopic observations of HZ Her are presented. Spectrograms with a dispersion of 30 Å mm^{-1} reveal a spectral type as late as F5 near minimum in the light curve with the G-band and metallic lines present. Narrow Fe lines show that HZ Her is not a rapid rotator. Low-dispersion (115 Å mm^{-1}) spectra, obtained with 10-minute time resolution, reveal rapid (10^{m}) variations in the λ4640 N III emission and in the λ4471 He I absorption features. The Hβ absorption is variable in equivalent width, and shows evidence of being partially filled with emission. (auth)

13406 A THEORY OF HIGHLY CONDENSED MATTER. Walecka, J.D. (Institute of Theoretical Physics, Department of Physics, Stanford University, Stanford, California 94305). Ann. Phys. (N.Y.) 83: No. 2, 491-529 (Apr 1974).

To discuss properties of cold, condensed stellar objects such as neutron stars, it is necessary to know the stress tensor $T_{\mu\nu}$, the source in Einstein's field equations, from nuclear matter densities upwards. To overcome some of the difficulties with the conventional many-body approach to this problem, a model relativistic, many-body, quantum field theory composed of a baryon field, a neutral scalar meson field coupled to the scalar density $\bar{\psi}\psi$, and a neutral vector meson field coupled to the conserved baryon current $i\bar{\psi}\gamma\lambda\psi$ is developed. For a uniform system of given baryon density ρ_B, the linearized theory obtained by replacing the scalar and vector fields by their expectation values, $\phi-\phi_0$, $V_\lambda - i\delta_{\lambda 4}V_0$ can be solved exactly. The resulting equation of state for nuclear matter exhibits nuclear saturation, and if the two dimensionless coupling constants in this theory are matched to the binding energy and density of nuclear matter, predictions are obtained for all other systems at all densities. In particular, neutron matter is unbound and the equation of state for neutron matter at all densities is presented; it extrapolates smoothly into the relativistic form $P=\epsilon$. Comparison is made with some conventional many-body calculations. The full field theory is developed by expanding the fields about the condensed values ϕ_0, V_0, and the unperturbed Hamiltonian is shown to correspond to the linearized theory. The energy shift due to these quantum fluctuations in the fields is related to the baryon Green's function. V_0 is related directly to ρ_B; ϕ_0, however, must be determined through a self-consistency relation involving the baryon Greens' function. The Feynman rules for this theory are developed. Expressions for the lowest-order contributions of the quantum fluctuations to the energy shift and ϕ_0 are derived. It is shown that the terms $q_\mu q_\nu$ in the vector-meson propagator do not contribute to these expressions, and a prescription involving assumptions on the limiting form of the theory as $\rho_B \to 0$ is presented which ensures that these lowest-order quantum fluctuations will yield finite results. (auth)

13407 APPARENT HORIZONS IN THE TWO-BLACK-HOLE PROBLEM. Čadež, A. (Univerza v Ljubljani, Fakulteta za Naravoslovje in Tehnologijo, Odsek za Fiziko, 61000 Ljubljana, Yugoslavia). Ann. Phys. (N.Y.) 83: No. 2, 449-457 (Apr 1974).

The apparent horizon of the two-black-hole problem on the time-symmetric spacelike hypersurface is studied. Its area is computed as a function of the separation parameter. The critical value of the separation parameter for which the two black holes merge is computed. (auth)

13408 ANISOTROPIC SPHERES IN GENERAL RELATIVITY. Bowers, R.L. (Center for Relativity Theory and Department of Astronomy, The University of Texas at Austin); Liang, E.P.T. Astrophys. J. 188: No. 3, 657-665 (15 Mar 1974).

The possible importance of locally anisotropic equations of state for relativistic spheres is discussed by generalizing the equations of hydrostatic equilibrium to include these effects. The resulting change in maximum equilibrium mass M and surface redshift z is found analytically in the case of incompressibility (ρ=const.) and a highly idealized expression for the anisotropy. Bondi's analysis of isotropic spheres is generalized to include anisotropy, and the maximum surface redshift is investigated without reference to specific equations of state. A numerical model [with $p(r) = 1/3\rho$ (r) and a special form of anisotropy] is then solved. In general, it is found that specific models lead to increases in z typically of the same order of magnitude as the fractional anisotropy. (auth)

13409 COMPOUNDS IN NEUTRON-STAR CRUSTS. Witten, T.A., Jr. (Joseph Henry Laboratories of Physics, Princeton University). Astrophys. J. 188: No. 3, 615-625 (15 Mar 1974).

The outer crust of a neutron star is thought to consist of crystalline matter with bare nuclei embedded in a relativistic electron gas making up the lattice. In this paper we give evidence that chemical compounds are stable in this environment. Specifically, helium and iron nuclei in a NaCl structure have a lower energy than they would in separated crystals. The binding amounts to 0.2 percent of the electrostatic energy or more, depending on the density. The present calculation extends previous work by including zero-point energy and all first-order electronic screening effects. We also present rough dispersion curves for the HeFe compound and zero-point energies for two related compounds, and we generalize two theorems about Coulomb lattice vibrations to the case of compounds. (auth)

13410 VY CANIS MAJORIS. IV. THE EMISSION BANDS OF ScO. Herbig, G.H. (Lick Observatory, Board of Studies in Astronomy and Astrophysics, University of California, Santa Cruz). Astrophys. J. 188: No. 3, 533-538 (15 Mar 1974).

The emission features in VY CMa near 6036, 6079 Å were discovered by Wallerstein in 1962 and later identified with ScO, independently, by Herbig and by Wallerstein. The recent laboratory analyses of the blue-green system of ScO by Adams, Klemperer, and Dunn, and of the orange system by Stringat, Athénour, and Fémênias, have been used to compute theoretical profiles for the unresolved ScO 0-0 band of the A $^2\Pi$–X $^2\Sigma$ (orange) system, under assumptions of LTE and optical thinness. The sharply peaked, almost linelike structure in VY CMa is shown to be due to the crowding of rotational structure near the band heads, on account of a very low rotational temperature; values of about 380°K in 1962 and 820° in 1966 were obtained by comparing the relative intensities of the 6036, 6079 Å peaks with theoretical prediction. (auth)

13411 A DUST-SHELL MODEL OF THE INFRARED OBJECT HD 45677. Apruzese, J.P. (Washburn Observatory, University of Wisconsin, Madison). Astrophys. J. 188: No. 3, 539-543 (15 Mar 1974).

A dust-shell model of the infrared star HD 45677 was constructed by means of a generalization of the mathematical techniques of Huang. The model shows that an isotropically scattering, uniform-density spherical circumstellar dust shell is able to account for the observed emergent energy distribution. The extinction properties of the grains required depend on the energy distribution incident on the inner boundary of the shell such that gray grains are needed if the stellar temperature is about 1.3×10^{4}°K and a λ^{-1} extinction law is indicated for a star of 2×10^{4}°K. This model for HD 45677 is compare with that of Dyck and Milkey, who propose free-free emission from a circumstellar gas shell to account for the observed infrared excess. (auth)

13412 HIGH-RESOLUTION SPECTRA OF COOL STARS IN THE 10- AND 20-MICRON REGIONS. Treffers, R.; Cohen, M. (Department of Astronomy, University of California, Berkeley). Astrophys. J. 188: No. 3, 545-552 (15 Mar 1974).

The spectra of two carbon stars, IRC+10216 and IRC+30219 (CIT 6), and of three oxygen-rich stars, VY CMa, α Ori, and W Hya, are presented with 2 cm^{-1} resolution. The carbon stars show an emission band attributable to circumstellar particles of silicon carbide. VY CMa and α Ori have excess emission at both 10 and 20 μ, characteristic of circumstellar silicate particles. However, other unidentified particles may be present in both types of star. No atomic or molecular features are seen. (auth)

13413 ARE 2-MICRON ABSORPTIONS AND 11-MICRON EMISSION OF M STARS RELATED? Faÿ, T.D., Jr. (Astronomy Department, Indiana University, Bloomington, Indiana 47401). Astrophys. J. 188: No. 3, 553-557 (15 Mar 1974).

Three properties of M stars are compared: (1)[3.5]–[11] colors, (2) two measures of 2.3-μ band absorption, and (3) two measures of 1.9-μ band absorption. We find that the 2.3-μ bands of 21 M giants and supergiants correlate with [3.5]–[11] colors at better than 99 percent confidence. A comparable relation exists between the mean 1.9-μ bands and [3.5]–[11] colors of 23 M giants and Miras. The sum of the 1.9-μ + 2.3-μ band intensities correlates with [3.5]–[11] color at better than the 99.8 percent level for 31 M stars. These relations are consistent with both CO and H_2O cooling of M star boundaries. Binaries and Ia supergiants appear to depart from these relations. (auth)

13414 REDISCUSSION OF ECLIPSING BINARIES. X. THE B STARS AG PERSEI AND CW CASSIOPEIAE. Popper, D.M. (Department of Astronomy, University of California, Los Angeles). Astrophys. J. 188: No. 3, 559-565 (15 Mar 1974).

As part of a continuing program, new spectrographic material is presented for the double-lined B-type eclisping binaries AG Per and CW Cep. Small but significant revisions of the masses and radii are found to be required. A collection of the most precisely known properties of B-type binary components is tabulated. Their locations in the mass–radius plane, when compared with predictions of models, show that, with the exception of α Vir A, all appear little or somewhat evolved, whereas α Vir A appears to be near core hydrogen exhaustion. (auth)

13415 MEASUREMENTS OF MAGNETIC FIELDS IN YOUNG MAIN-SEQUENCE STARS. Boesgaard, A.M. (Institute for Astronomy, University of Hawaii). Astrophys. J. 188: No. 3, 567-569 (15 Mar 1974).

The Zeeman analyzer at the coudé spectrograph of the 224-cm (2.2-m) telescope on Mauna Kea has been used to search for magnetic fields in young main-sequence stars at a dispersion of 3.3 Å mm^{-1}. Eight stars of spectral types FO V-KO V were selected as young stars by one or more criteria: intense Ca II emission cores, high Li content, high axial rotation. Four of the stars clearly show no detectable magnetic fields and a fifth one probably has no field. Ten spectrograms of γ Vir N indicate that it does have a small, possibly variable magnetic field. There is marginal evidence in favor of weak magnetic fields in the two coolest stars, ξ Boo A and 70 Oph, both of which show intense Ca II emission. (auth)

13416 ROTATIONAL DISTORTION OF STELLAR ABSORPTION LINES. I. PARAMETERS FROM PHOTOGRAPHIC SPECTRA. Stoeckley, T.R.; Morris, C.S. (Department of Astronomy, Michigan State University). Astrophys. J. 188: No. 3, 579-594 (15 Mar 1974).

A differential corrections procedure is described for deriving the half-width, shape, central depth, and equivalent width (as well as their estimated uncertainties) of rotationally broadened absorption-line profiles from high-dispersion photographic spectra. A method is described for combining several profiles into a single, improved profile which can be reanalyzed. The capabilities of the procedure are illustrated with exhaustive tests on actual profiles and on synthetically generated noisy profiles. We find that this procedure allows the line shape of a photographically recorded profile to be measured to an accuracy which is sufficient for later analysis of the rotational distortion of the star and estimates of its axial inclination and differential rotation. (auth)

13417 THICK-TARGET MEASUREMENT OF THE (p,γ) STELLAR REACTION RATES ON THE NUCLIDES ^{12}C, ^{29}Si, ^{46}Ti, ^{47}Ti, AND ^{56}Fe. Roughton, N.A. (Regis College, Denver, Colorado 80221, and Nuclear Physics Laboratory); Fritts, M.J.; Peterson, R.J.; Zaidins, C.S.; Hansen, C.J. Astrophys. J. 188: No. 3, 595-601 (15 Mar 1974).

Stellar reaction rates for (p,γ) on ^{12}C, ^{29}Si, ^{46}Ti, ^{47}Ti, and ^{56}Fe have been obtained from thick-target measurements. These nuclei represent different combinations of resonant and continuum structure in the cross-sections, and each presents particular problems in analysis. The experimental and theoretical techniques are discussed, and a comparison is made to stellar rates derived from a statistical nuclear model. The capture reaction on ^{56}Fe is discussed in some detail because of the presence of a strong nonstatistical state—an isobaric analog resonance—in the energy range of interest. Some discussion is included regarding differences between experimental and theoretical cross-sections. (auth)

13418 THE LUMINOSITIES OF POPULATION II CEPHEIDS. Böhm-Vitense, E. (Astronomy Department, University of Washington, Seattle, Washington 98195). Astrophys. J. 188: No. 3, 571-577 (15 Mar 1974).

A method is described for the distance determination of pulsating stars measured colors and radial velocities. It follows the line of thought given by Baade and Wesselink. This method does not require any calibration by conventional distance determinations once the depth variation of the expansion velocities in the pulsating stars is known from theory. A period-luminosity relation for Population II stars with periods between 17.3 and 28.5 days is derived from the stars W Vir, TW Cap, and star No. 42 in M5. (auth)

13419 THE EVOLUTION OF SUPERNOVA REMNANTS. I. SPHERICALLY SYMMETRIC MODELS. Chevalier, R.A. (Princeton University Observatory, Princeton, New Jersey). Astrophys. J. 188: No. 3, 501-516 (15 Mar 1974).

The evolution of supernova remnants is studied using a spherically symmetric hydrodynamic code with a magnetic field approximately included. Properties of the emitted radiation are investigated. Particular attention is paid to the late phases when a dense neutral shell forms which accretes matter from both the interstellar medium and the hot interior. The shell absorbs hard ultraviolet and soft X-ray photons. The interstellar magnetic field produces the dominant pressure in the shell and determines its density and thickness. Results for explosions of 3×10^{50} ergs in gas of densities 10^{-2}, 10^{0}, and 10^{2} cm $^{-3}$ show that harder radiation emerges from explosions in higher density gas. Using a scaling law, the results can be extended to a range of densities and initial energies. If cooling by collisionally heated grains occurs in the high-density case, about 20 percent of the total energy is radiated in the infrared in the early stages. In later phases, infrared cooling by radiation heated grains and infrared line emission may be significant, particularly in the low-density case. At the end of a typical run, the integrated radiated energy is about equally divided between infrared and ionizing radiation. Interaction of the supernova shock with a large cloud decreases the total kinetic energy, and increases the thermal energy due to the reflected shock. The possibility that the initial supernova energy is deposited as relativistic particles is investigated; it is found that the shock radius a few thousand years after the explosion is fairly independent of the initial conditions, while differences when the radius is of order 1 pc are considerable. Comparison is made with observations. The observed relation between the surface brightness and diameter of old supernova remnants can be understood on the basis of the present models and van der Laan's theory for the radio emission. (auth)

13420 A STUDY OF INTERSTELLAR POLARIZATION AT THE λλ4430 AND 5780 FEATURES IN HD 183143. Martin, P.G. (David Dunlap Observatory and Scarborough College, University of Toronto, Toronto, Canada); Angel, J.R.P. Astrophys. J. 188: No. 3, 517-521 (15 Mar 1974).

If the diffuse interstellar features originate in grains which cause the observed interstellar polarization, or in smaller grains similarly aligned, then polarization structure is predicted at the features, of amplitude $\Delta p \simeq 1.4\bar{p}\Delta\tau/\bar{\tau}$, where $\bar{p}$ is the polarization in the nearby continuum and $\Delta\tau/\bar{\tau}$ is the fractional change in optical depth. Observations of the λλ4430 and 5780 features in HD 183143 reveal no changes in polarization at this predicted level. Host grains which are relatively poorly aligned and probably rather small are consistent with this result and the other properties of the diffuse features, though now alternative, nongrain origins may appear more attractive. (auth)

13421 A SPECTROSCOPIC STUDY OF THE OPEN CLUSTER M39. Abt, H.A. (Kitt Peak National Observatory, Tucson, Arizona); Sanders, W.L. Astrophys. J. 186: No. 1, 177-183 (15 Nov 1973).

M39 is found to be intermediate among open clusters in its mean stellar rotational velocity and its frequency of binaries. A study of the 15 brightest members yielded orbital elements for four spectroscopic binaries; one other star has double lines. For six well-studied clusters there is a well-defined inverse correlation between mean rotational velocity and frequency of binaries with periods less than about 10 days; if longer-period binary motion is also effective in reducing rotational velocities, then the results imply preferential inclinations for some clusters. (auth)

13422 ARE ALL METALLIC-LINE STARS BINARIES? OBSERVATIONS OF THREE STARS IN COMA. Conti, P.S. (Joinr Institute for Laboratory Astrophysics, University of Colorado, Boulder); Barker, P.K. Astrophys. J. 186: No. 1, 185-191 (15 Nov 1973).

A radial-velocity study at coudé dispersion of three metallic-line stars in Coma shows 17 Com B to be a spectroscopic binary with a period of 68.290 days. No evidence is found for duplicity in the two other stars observed. Five Am stars in Coma have now been studied at high dispersion, and only two of these have been detected as binaries. Thus there are strong grounds for believing that at least a few Am stars are single; a conclusion consistent with the suggestion that slow rotation along is the necessary and sufficient condition for the Am phenomenon. (auth)

13423 ON THE POSSIBILITY OF NEUTRON-STAR FORMATION IN CARBON-DETONATION SUPERNOVAE. Bruenn, S.W. (Florida Atlantic University, Boca Raton, Florida). Astrophys. J. 186: No. 3, 1157-1169 (15 Dec 1973).

The detonation-postdetonation evolutions of a variety of pre-"carbon-detonation" supernovae have been computed in order to determine the influence of model parameters and input physics on the possibility of forming neutron stars in these events. A number of conclusions are drawn. In particular, a collapse immediately prior to detonation would have a very positive influence on neutron star formation if this collapse were reasonably dynamic. The nonadiabaticity of this collapse, and the abundance of ^{12}C in the core at this time, are also very important considerations. On the other hand, it is shown that possible future revisions in the β-rates are unlikely to significantly affect the postdetonation evolution, and that a prior quasi-static phase of electron capture, or the occurrence of an off-center detonation, tends to have a negative influence on neutron-star formation. (auth)

13424 THE COLOR-MAGNITUDE DIAGRAM OF THE METAL-POOR SOUTHERN GLOBULAR CLUSTER NGC 4372. Hartwick, F.D.A. (University of Victoria); Hesser, J.E. Astrophys. J. 186: No. 3, 1171-1178 (15 Dec 1973).

A photometric UBV study to V=17.2 of the globular cluster NGC 4372 has revealed: (1) a color-magnitude diagram characteristic of very metal-poor clusters; (2) a large and variable absorption in front of the cluster; and (3) a distance modulus of 13.65 ± 0.20. Attention is drawn to a relatively well populated group of stars lying above the horizontal branch in the color-magnitude diagram. (auth)

13425 MULTIMODAL RADIAL PULSATIONAL INSTABILITY IN A PRENOVA MODEL. Sastri, V.K.; Simon, N.R. (Behlen Laboratory of Physics, and Behlen Observatory, University of Nebraska, Lincoln). Astrophys. J. 186: No. 3, 997-1005 (15 Dec 1973).

A prenova model, consisting of a white dwarf unstably burning a shell of accreted hydrogen, was tested for stability against radial pulsations. The pulsational analysis included terms due to thermal imbalance. The model was found to be pulsationally unstable in all of the modes examined, save one in which the thermal-imbalance integrals

made the crucial damping contribution. An evaluation of some uncertainties in the present analysis is followed by a more general discussion in which it is concluded that multimodal radial pulsational instability can occur in a wide variety of thermally unstable, shell-burning stars. A brief discussion of some consequences of such instability, including its possible connection with the rapid blue variables, concludes the article. (auth)

13426 BINARIES AND SUPERNOVAE OF TYPE I. Whelan, J.; Iben Jr., I. (University of Illinois). Astrophys. J. 186: No. 3, 1007-1014 (15 Dec 1973).

It is suggested that the immediate progenitors of Type I supernovae in elliptical galaxies are binary systems of long period (1–6 years) that have evolved from an initial configuration consisting of a light secondary of mass less than or equal to 0.8 $M_\odot$ and a primary of intermediate mass (1.8–3 $M_\odot$), with orbital period between 5 and 9 years. Beginning on the main sequence, the primary evolves rapidly and, following mass loss and/or mass transfer, becomes a carbon–oxygen white dwarf of mass close to 1.4 $M_\odot$. The secondary, now of mass 0.8 $M_\odot$, evolves for 10^{10} years before reaching the asymptotic giant branch. On swelling beyond its Roche surface, the secondary transfers mass onto the primary which then (we presume) develops rapidly into a supernova. An examination of the frequency of binary systems with appropriate orbital characteristics shows that our conjecture is not inconsistent with the available data concerning the frequency of Type I supernovae. (auth)

13427 INTERNAL DUST IN GASEOUS NEBULAE. Liebowitz, E.M. (Department of Physics and Astronomy and the Wise Observatory, Tel-Aviv University, Israel). Astrophys. J. 186: No. 3, 899-907 (15 Dec 1973).

A least-squares fit of observed ratios of hydrogen lines radio fluxes in the planetary nebula NGC 7027 to the corresponding theoretical values, with a two parameter reddening law, reveals the existence of a large amount of internal dust in this nebula. A similar analysis of observations in the Orion Nebula indicates an optical thickness for absorption between 2.5 and 9 at Hβ of a dust component in this nebula. The interpretation of the infrared fluxes observed in these two nebulae as the thermal radiation from dust grains within the gaseous sources is thus greatly strengthened. (auth)

13428 A SURVEY OF H-ALPHA EMISSION IN EARLY-TYPE HIGH-LUMINOSITY STARS. Rosendhal, J.D. (Steward Observatory, University of Arizona, Tucson). Astrophys. J. 186: No. 3, 909-937 (15 Dec 1973).

High-dispersion Hα spectrograms have been obtained of 62 early-type high-luminosity stars in order to search for evidence for mass loss in stars in the upper left portion of the H-R diagram. In addition to a study of the strength and shape of Hα, detailed radial-velocity measurements have been made to look for possible velocity differences among the strong lines in the red region of the spectrum. The results of this investigation indicate that the lower limits to the absolute visual magnitudes at which Hα begins to show conspicuous emission are $M_v \sim -5.8$ in the B0–B1 stars and $M_v \sim -6.8$ in the B8–A3 stars. There is evidence from the radial-velocity studies for differential expansion and hence mass loss for stars approximately 0.5 mag less luminous than these limiting luminosities. Among the early B stars it appears that there is a critical luminosity of $M_{bol} \simeq -8.2$ at which strongly accelerated large-scale flows may develop. The apparent existence of an abrupt change in the velocity-gradient-luminosity relationship between the early and late B stars suggest that the mechanism driving the flows changes at about 13,000°K. Study of the line strengths indicates that the net strength of a Hα is correlated with both luminosity and temperature, with there being no discontinuity in the relationship as the line goes from a net absorption to a net emission feature. Evidence is presented to support the hypothesis that all early-type supergiants which show emission are intrinsic spectrum variables. It is also argued that the presence of reversals near the center of the Hα absorption cores in several O stars and lower-luminosity early B supergiants may provide evidence for the existence chromospheres in these stars. (auth)

13429 ULTRAVIOLET PHOTOMETRY FROM THE ORBITING ASTRONOMICAL OBSERVATORY. XII. THE ECLIPSING BINARY LY AURIGAE. Heap, S.R. (Laboratory for Optical Astronomy, Goddard Space Flight Center, Greenbelt, Maryland 20771). Astrophys. J. 186: No. 3, 939-949 (15 Dec 1973).

The eclipsing binary LY Aur (09.5 III) was observed over a period of four days in 1972 March with the Wisconsin instrumentation on OAO-2. Complete light curves were obtained at the following wavelengths: 4250, 3320, 2980, 2460, 1910, and 1550 Å. The difference in phase between successive observations was 0.017. Where there is overlap (λ4250 and λ3320), the satellite observations agree with ground-based observations within the uncertainties of the data. The light curves at all wavelengths indicate the presence of strong tidal interaction. The primary eclipse depth increases in the ultraviolet, while the secondary eclipse depth remains almost constant. (auth)

13430 THE ROTATIONAL SYNCHRONISM OF THE Ap STAR 41 TAURI. Wolff, S.C. (Institute for Astronomy, University of Hawaii). Astrophys. J. 186: No. 3, 951-957 (15 Dec 1973).

Four color (ubvy) photometry is used to derive a period of 7.227 days for the Si-type Ap star 41 Tau. This period is compatible with the period versus line-width relationship for Ap stars. The star is also a spectroscopic binary, and the orbital period is identical to the photometric period. Rotation and revolution are therefore synchronized. Zeeman measurements are uncertain because of the substantial rotational broadening, but the field does not exceed 1000 gauss. The lines of Si II, Sr II, and probably Ti II show small variations in strength. The amplitudes of the light curves at the four observed wavelengths can be accounted for by a temperature variation of about 200° over the stellar surface. (auth)

13431 53 CAMELOPARDALIS AND THE TRANSVERSE ZEEMAN EFFECT IN Hβ. Borra, E.F. (Hale Observatories, Carnegie Institution of Washington). Astrophys. J. 186: No. 3, 959-960 (15 Dec 1973).

Models for the magnetic star 53 Camelopardalis show that theoretical values for the linear polarization in Hβ, using Unno's LTE theory of radiation transfer in the presence of a magnetic field, are two orders of magnitude smaller than the observed values reported by Kemp and Wolstencroft. (auth)

13432 POLARIMETRY OF R CORONAE BOREALIS AT VISUAL LIGHT MINIMUM. Coyne, G.V., S.J. (University of Arizona, Tucson); Shawl, S.J. Astrophys. J. 186: No. 3, 961-966 (15 Dec 1973).

Changes in the wavelength dependence of the polarization for R CrB during the visual light minimum of 1972 March–June are interpreted as due to scattering from graphite particles of different sizes ranging from 0.05 μ to 0.10 μ mean particle radius. At different times clouds with particles of different mean particle sizes dominate the observed polarization. This agrees with the "discrete cloud model" adduced to explain the infrared observations. (auth)

13433 OPACITY EFFECTS AND THE CLASSIFICATION OF CARBON STARS. Scalo, J.M. (Department of Astronomy, University of California, Los Angeles). Astrophys. J. 186: No. 3, 967-978 (15 Dec 1973).

The dependence of the stratification of easily ionized metals on the CN opacity in cool carbon stars is examined. The larger electron pressure in stars with small (C–O)/H ratios strengthens the lines of neutral metals, simulating a temperature decrease. Synthetic spectra computed for modified diffusion-approximation carbon-star atmospheres are used to show that many of the temperature criteria in the C classification scheme are dependent on this opacity effect. This effect also is capable of explaining the discrepancy between color temperatures and spectral temperatures, the correlation of C_2 strength with Na D strength, and the tendency for strong lithium lines and CaCl bands to occur in stars with very weak C_2 bands. (auth)

13434 CARBON STARS IN OMEGA CENTAURI. Wing, R.F. (Perkins Observatory, The Ohio State and Ohio Wesleyan Universities); Stock, J. Astrophys. J. 186: No. 3, 979-988 (15 Dec 1973).

Three carbon stars lying within 20′ of the center of the globular cluster ω Centauri have been noted on objective-prism plate. Two of these lie at the extreme tip of the red-giant branch and are confirmed cluster members from radial-velocity measurements; the third, somewhat bluer and fainter, has a discordant velocity. Narrow-band photometry in the near-infrared shows that the two members are cooler ($T_{eff} \simeq 3800$°K) and more luminous ($M_v \simeq -2.5$) than most of the Population II CH stars in the field, but their CN strengths are normal for carbon stars of their temperatures. They have very different C_2 strengths and must have mixed different amounts of processed material to their surfaces. Several reasons are given for suspecting the presence of additional carbon stars and related objects (S stars, barium stars, and strong-CN K giants) in ω Cen and other globular clusters. A search for such stars should be made along the entire extent of the giant branch, and a variety of observing techniques are briefly discussed. (auth)

13435 REVISED PERIOD AND MINIMUM-LIGHT SPECTRUM OF NML TAURI. Wyckoff, S.; Wehinger, P. (Wise Observatory, Tel-Aviv University, Tel Aviv, Israel). Astrophys. J. 186: No. 3, 989-991 (15 Dec 1973).

A period of 465 days has been determined from recent observations of the infrared object NML Tau. A spectrogram of NML Tau near minimum light (V=14.2) exhibits a later spectral type than that of R Cas at the same phase. Both the sepctroscopic and the photometric observations indicate that the maximun of NML Tau which occurred in 1973 March was 1 mag brighter in V than the maximum observed six cycles previously in 1965 August, and 3 mag brighter than the 1966 maximum. (auth)

13436 NEUTRAL HYDROGEN OBSERVATIONS OF EIGHT GLOBULAR CLUSTERS. Knapp, G.R.; Rose, W.K.; Kerr, F.J. (Astronomy Program, University of Maryland). Astrophys. J. 186: No. 3, 831-839 (15 Dec 1973).

Sensitive observations of H I profiles in the directions of eight globular clusters made with the NRAO 140-foot telescope give upper limits on the neutral hydrogen content of the clusters ranging from 0.8

to 27 $M_\odot$. These results have interesting implications for the evolution of globular-cluster stars and for the age of the Galaxy. (auth)

13437 THE LONG-TERM BEHAVIOR OF THE MAGNETIC FIELD OF β CORONAE BOREALIS. Borra, E.F.; Dworetsky, M.M. (Hale Observatories, Carnegie Institution of Washington). Astrophys. J. 186: No. 1, 211-217 (15 Nov 1973).

Because of conflicting interpretations of its magnetic field variations, we have examined all of the Zeeman analyzed plates of β CrB in the files of the Hale Observatories. We measured all of the plates not previously measured and also all of the plates taken close to south polarity extremum. Our measurements confirm some of the small values of H_s at the south polarity extremum reported by Babcock. However, we find some observational evidence that south polarity extremum there is a correlation between measured field strength and photographic density of the spectroscopic plate. Numerical models show that the effect should be present in an oblique-rotator model with a displaced dipole configuration of the magnetic field. This effect could be responsible for the small fields reported by Babcock and casts further doubts on the reality of nonperiodic variations in β CrB. (auth)

13438 THE EFFECT OF Fe I ABSORPTION ON THE MG II EMISSION AT 2795 Å IN α ORIONIS. Modisette, J.L.; Nicholas, R.E. (Houston Baptist College, Houston, Texas); Kondo, Y. Astrophys. J. 186: No. 1, 219-222 (15 Nov 1973).

The Fe I absorption line at 2795.01 Å is derived from the observations of Mg II resonance emission in α Orionis by Kondo et al. A spectrum is synthesized, including Mg II emission and self-absorption and also Fe I absorption, which accounts for the observed asymmetry in the Mg II 2795.5 line and for the discrepancy between the theoretical and observed intensity ratios of the two Mg II lines. The astrophysical significance of this strong Fe I absorption is discussed. (auth)

13439 NEUTRON ENERGY DISTRIBUTIONS AND TERMINATION OF THE r-PROCESS. Johns, O.; Reeves, H. (Institut d'Astrophysique, 98 bis Bd. Arago, 75 Paris 14, France). Astrophys. J. 186: No. 1, 233-238 (15 Nov 1973).

The r-process formation of superheavy elements is calculated including the effect of fission induced by high-energy neutrons in the tail of the Maxwell-Boltzmann distribution. Even for a surface symmetry parameter $\kappa=1.79$, favorable to superheavy production, the maximum mass number A_{max} produced in detectable amounts is found to drop by about 20 units over a range of neutron densities from 10^{24} to 10^{30} cm^{-3}. The predicted superheavy mass range A=294 to A=298 is not produced for $N \gtrsim 10^{28}$ cm^{-3}. Also a parametrization of the r-process path is presented which is independent of β-decay rates. (auth)

13440 NUCLEOSYNTHESIS IN SUPERMASSIVE STAR EXPLOSIONS. Audouze, J.; Fricke, K.J. (California Institute of Technology, Pasadena). Astrophys. J. 186: No. 1, 239-248 (15 Nov 1973).

The results of a detailed implosion-explosion calculation for a supermassive star have been used to determine the hydrogen nucleosynthesis during the bounce. An extended network of nuclear reactions describing the CNO-Ne cycles has been employed. Dynamically unstable supermassive objects are shown to be of interest regarding the production of comparatively rare isotopes like ^{13}C, ^{15}N, ^{17}O, and ^{22}Ne. (auth)

13441 BROAD-BAND 20-MICRON PHOTOMETRY OF 76 STARS. Morrison, D.; Simon, T. (Institute for Astronomy, University if Hawaii). Astrophys. J. 186: No. 1, 193-206 (15 Nov 1973).

Photometry in the 16- to 28-μ spectral band, made at Mauna Kea Observatory in 1971-1973, is presented for 76 stars, with a precision in most cases of 0.05 mag. The sample contains stars of classes B through M, as well as several carbon and S stars; most are Mira, semiregular, or irregular variables. The five primary standards and their 20-μ magnitudes are α Tau (-3.23), α Ori(-5.74), α Boo (-3.32), α Her (-4.26), and β Peg (-2.74). Observations of stars presumed to have black-body spectra, including α CMa, confirm the calibration adopted in a previous paper. An unexpected excess of 0.3 mag observed for α Lyr is tentatively attributed to chromospheric emission. Most stars were observed over several months, and 16 (all Mira variable) showed variations up to 0.9 mag) at this wavelength. We present light curves for variables o Cet, R Cnc, S CrB, and R Aqr, and also for one Mira that did not vary, R Leo. A comparison of 20-μ magnitudes for these 76 stars with published data at 8.5 and 11 μ shows a strong correlation between brightness at 11 and 20 μ, with supergiants, including several Lc variables, having the largest excesses at both wavelengths. (auth)

13442 ABSOLUTE SPECTROPHOTOMETRY OF THE PLANETARY NEBULA NGC 7027 IN THE WAVELENGTH RANGE 7000-10,400 Å. Kolotilov, E.A.; Noskova, R.I. (Shternberg Astronomical Institute, Moscow). Sov. Astron.-AJ 17: No. 5, 611-614 (Mar 1974).

Absolute intensities [erg·cm^{-2} · sec^{-1}] have been measured for ~40 emission lines in the infrared spectrum of NGC 7027. The continuum energy distribution of the nebula is established and corrected for interstellar absorption. The Paschen discontinuity $D_p=0.25\pm0.05$ is in good agreement with the theoretical value of 0.23. A theoretical continuum is calculated for NGC 7027 in the range λλ 3000-10,000 A; calibration against the present measurements yields a good fit to the radio observations. (auth)

13443 SPECTROPHOTOMETRY AND MULTICOLOR POLARIMETRY OF XX CAMELOPARDALIS IN ITS QUIESCENT PHASE. Kolotilov, E.A.; Orlov, M.Y.; Rodriquez, M.H. (Central Astronomical Observatory, Academy of Sciences of the Ukrainian SSR, Kiev). Sov. Astron.-AJ 17: No. 5, 615-616 (Mar 1974).

The spectrum of the R CrB star XX Cam has been scanned photoelectrically over the range 7500-3300 Å. Its energy distribution corresponds to spectral type G2. Polarimetric measurements of XX Cam have been made in 10 wavelength bands (7650-3700 Å). The position angle θ for the electric vector is similar to values of θ for interstellar polarization in this direction; the wavelength dependence of the percentage polarization p is typical interstellar polarization, but the value of p is higher than for neighboring stars. (auth)

13444 BEHAVIOR OF THE ULTRAVIOLET Mg II DOUBLET IN STELLAR SPECTRA. Oganesyan, D.B. (Byurakan Astrophysical Observatory, Academy of Sciences of the Armenian SSR). Sov. Astron.-AJ 17: No. 5, 617-618 (Mar 1974).

An empirical curve is derived for the relation between the ultraviolet λ2800 Mg II doublet and the spectral type of a star, based on equivalent linewidths for eight BO-kO stars. Highly sensitive to spectral type, the relation has a maximum at GO. Observations of the λ2800 doublet would be valuable for dealing with various problems concerning the physics of stellar atmospheres—in particular, for refining the spectral classification of stars. (auth)

13445 GRAVITY DARKENING IN THE CLOSE BINARY SYSTEM β LYRAE. Alduseva, V.Y. (Shternberg Astronomical Institute, Moscow). Sov. Astron.-AJ 17: No. 5, 619-621 (Mar 1974).

The results of spectrophotometry of the β Lyr system in 1963 at photographic wavelengths are discussed. At all phase angles except near primary minimum, the behavior of the spectrophotometric gradient ϕ_1 reflects the variation in the spectral type of the primary B8 component over its surface. The diminished brightness of β Lyr at secondary minimum can be explained by a variation in T_{eff} over the surface of the primary component. The factor governing the T_{eff} variation is gravity darkening of the primary—component surface as distorted by rotation and tidal effects. (auth)

13446 CALCULATION OF ECLIPSING-BINARY ELEMENTS FOR HOT COMPONENTS WITH NONLINEAR LIMB DARKENING. Shul'berg, A.M. (Astronomy Department, Odessa University). Sov. Astron.-AJ 17: No. 5, 622-626 (Mar 1974).

To extend a previous analysis, an improved estimate is obtained for the magnitude of the nonlinear limb-darkening effect in eclipsing binary systems. Under the most favorable circumstances the effect of nonlinearity would by $0^m.02$-$0^m.03$ for either occultation or transit eclipse. A synthetic light curve is solved as an illustration, whereby it is shown that the elements of an eclipsing system in which the nonlinearity effect is present can be derived by conventional methods. Direct identification of the nonlinearity effect in actual eclipsing systems would not be feasible at this time. (auth)

13447 GRAVITATIONAL MASS DEFECT OF ROTATING WHITE DWARFS AND NEUTRON STARS. Vartanyan, Y.L.; Ovsepyan, A.V.; Adzhyan, G.S. (Byurakan Astrophysical Observatory, Erevan University). Sov. Astron.-AJ 17: No. 5, 627-630 (Mar 1974).

In an investigation of the gravitational mass defect of rotating white dwarfs and neutron stars, the central-density dependence of the mass, mass defect, and pulsation period is calculated for several series of configurations corresponding to different values of the angular momentum. The influence of rotation on the energy curves of white dwarfs and neutron stars is examined. (auth)

13448 MAGNETOHYDRODYNAMIC THEORY FOR THE FIGURES OF EQUILIBRIUM OF ROTATING, SELF-GRAVITATING FLUID MASSES. Oganesyan, R.S.; Abramyan, M.G. (Erevan University). Sov. Astron.-AJ 17: No. 5, 631-633 (Mar 1974).

An analysis is made of the possibilities for the existence of rotating figures of equilibrium for self-gravitating, conducting fluid masses in the presence of internal toroidal-type magnetic fields. The limiting value of the angular velocity for equilibrium rotation increases with the field strength. If the field strength exceeds a critical value, $B_0 > B_c = \omega a(2\pi\rho)^{1/2}$, then Maclaurin ellipsoids (a=b>c) will become prolate ellipsoids (a=b>c), comprising a new type of figures of equilibrium; and if B_0 is sufficiently large, the configuration will be nearly cylindrical. The critical field strength $B_0=B_c$ corresponds to a spherical figure of equilibrium in steady rotation. (auth)

13449 INFLUENCE OF PLASMA ELECTRIC FIELDS ON HYDROGEN SPECTRAL LINES. Dolginov, A.Z.; Yakovlev, D.G.

(A. F. Ioffe Physicotechnical Institute, Academy of Sciences of the USSR). Sov. Astron.–AJ 17: No. 5, 634-639 (Mar 1974).

It is shown that the electric fields of the oscillations of a plasma have an appreciable effect on the profile and polarization of the spectral lines of the hydrogen atom. A method is proposed for determining these fields from the line characteristics. When the Stark shifts of the atomic levels are much less than the field frequency the moments of the distribution function of the electric field can be determined from the profile and polarization of a line. In the opposite case, the dispersion and mean frequency of the field can be determined. The results of the paper can be used to analyze radiation emitted from turbulent regions on the sun and stars. (auth)

13450 COLOR EXCESS OF CLASSICAL GALACTIC CEPHEIDS. Yakimova, N.N. (Shternberg Astronomical Institute, Moscow). Sov. Astron.–AJ 17: No. 5, 695-696 (Mar 1974).

Two extensive surveys of the color excesses E_{B-V} of classical Cepheids in our galaxy are compared. Arguments are given for preferring the excesses determined by Tsarevskii and the author to those obtained by Makarenko . (auth)

13451 THE z DISTRIBUTION OF STARS OF VARIOUS SPECTRAL TYPES. Borzov, G.G. (Shternberg Astronomical Institute, Moscow). Sov. Astron.–AJ 17: No. 5, 659-662 (Mar 1974).

A method described previously is applied to study the space distribution of late-type stars on the basis of the Stockholm Spectral Catalog. Functions are given for the star-density distribution along the z coordinate. Type A stars exhibit a discrete change in their logarithmic density gradient at z=300-400 pc. Logarithmic gradients are derived for stars later than FO. The star density in the solar neighborhood is found to be approximately twice the prevailing estimate. (auth)

13452 INTENSITY OF ZEEMAN LINE COMPONENTS IN A PLASMA. Kleiman, E.B.; Otringel', I.M. (N. I. Lobachevskii University, Gor'kii Institute of Terrestrial Magnetism, the Ionosphere, and Radio-Wave Propagation, Siberian Branch, Academy of Sciences of the USSR). Sov. Astron.–AJ 17: No. 5, 697-698 (Mar 1974).

The intensities of the different Zeeman components are derived for an atom in a magnetoactive plasma. The plasma medium may have a substantial influence on the Zeeman intensity distribution for radio lines. (auth)

13453 MULTIPLE STAR ENCOUNTERS IN SYSTEMS WITH STARS OF NONUNIFORM MASS. Danilov, V.M. Sov. Astron.–AJ 17: No. 5, 663-665 (Mar 1974).

An expression is obtained for Agekyan's factor $\lambda(\bar{N})$ correcting for multiple star encounters in a system with a constant mean density of field stars but with members of nonuniform mass. (auth)

13454 NOVA OUTBURSTS AND THE GENERATION OF SUBCOSMIC RAYS. Rumyantsev, A.A. (M. I. Kalinin Polytechnic Institute, Leningrad). Sov. Astron.–AJ 17: No. 5, 585-587 (Mar 1974).

A mechanism for generating subcosmic rays in nova envelopes is discussed. The force due to absorption of free-free radiation emitted by electrons in the envelope plasma can accelerate protons and nuclei to energies of $\simeq$100 MeV. Such particles can then be further accelerated by the Fermi mechanism in the turbulent envelope to energies comparable to their rest energy. The acceleration of electrons and their synchrotron radiation at the epoch of maximum light are considered. The radiation will appear in the far infrared, and its total energy will be comparable to the energy of the outburst. (auth)

Quasi-Stellar, Radio, and X-Ray Sources

Refer also to abstracts 13372, 13405, 13567, and 13568.

13455 1-MILLIMETER OBSERVATIONS OF THE GALACTIC H II REGIONS M42 AND DR 21. Ade, P.A.R.; Clegg, P.E. (Physics Department, Queen Mary College, Mile End Road, London E.1); Rather, J.D.G. Astrophys. J. Lett. 189: No. 1, L23-L26 (1 Apr 1974).

We have made measurements of the 1.4-mm fluxes from the Galactic H II regions DR 21 and the Orion Nebula. Measurements at 350 μ have been used in the interpretation of these data. A crude mapping of the Orion Nebula leads to an optically thin thermal model consisting of a 70°K, 1 arc min source set on a more extended region, ~3 arc min in diameter, at a temperature of 30°K. A measured flux density of 32 ± 8 f.u. from DR 21 confirms the excess emission reported at 350 μ and gives a mean spectral index of -3.1 for the spectral region 350 μ 1.4 mm. (auth)

13456 DETECTION OF POSSIBLE MASER EMISSION NEAR 3.48 MILLIMETERS FROM AN UNIDENTIFIED MOLECULAR SPECIES IN ORION. Snyder, L.E. (Joint Institute for Laboratory Astrophysics, University of Colorado); Buhl, D. Astrophys. J. Lett. 189: No. 1, L31-L33 (1 Apr 1974).

We have detected a group of unidentified molecular emission lines near 86,245 MHz (~3.48 mm) in the direction of the Orion Nebula molecular cloud. The narrow line widths and the compactness of the Orion emission region suggest that we have observed the first millimeter-wave maser. (auth)

13457 THE DISTANCE OF BL LACERTAE. Oke, J.B.; Gunn, J.E. (Hale Observatories, California Institute of Technology, Carnegie Institution of Washington). Astrophys. J. Lett. 189: No. 1, L5-L8 (1 Apr 1974).

The extended object around BL Lacertae has been observed spectrophotometrically, with the use of both an annulus and round apertures. The annulus spectrum shows the absorption lines normally seen in spectra of ordinary giant galaxies; these lines yield a redshift z=0.07. It is shown that (1) the central source is a power-law spectrum with $\alpha=-1.55$; (2) the underlying galaxy energy distribution is consistent with that of a normal giant elliptical galaxy; (3) the interstellar extinction corresponds to $E_{B-V}=0.28$; (4) if $H_0=60$ km s^{-1} Mpc^{-1} is used, the absolute visual magnitude of the galaxy is -22.9 and the distance is 350 Mpc (the central source at the brightest we have observed it is 7 times as bright as the galaxy); (5) on the assumption that the redshift z=0.07, the central source is similar in spectral index and luminosity to quasars such as 3C 48, 3C 279, and 3C 345, provided a cosmological distance is assumed for these latter quasars. (auth)

13458 MILLISECOND TEMPORAL STRUCTURE IN CYGNUS X-1. Rothschild, R.E.; Boldt, E.A.; Holt, S.S.; Serlemitsos, P.J. (NASA/Goddard Space Flight Center, Greenbelt, Maryland 20771). Astrophys. J. Lett. 189: No. 1, L13-L16 (1 Apr 1974).

Evidence is presented for the X-ray variability of Cyg X-1 on time scales down to 1 ms. Several "bursts" of millisecond duration are observed. The duty cycle for bursting is estimated to be $\gtrsim 2\times10^{-4}$ averaged over the entire 49-s exposure, although the maximum burst activity is associated with a region of enhanced emission lasting about 1/3 s. Such bursts may be associated with turbulence in disk accretion at the innermost orbits for a black hole. (auth)

13459 PHOTOELECTRIC SPECTROPHOTOMETRY OF THE CYGNUS LOOP. Miller, J.S. (Lick Observatory, Board of Studies in Astronomy and Astrophysics, University of California, Santa Cruz). Astrophys. J. 189: No. 2, 239-248 (15 Apr 1974).

Photoelectric measurements of line and continuum intensities at three places in the Cygnus Loop are presented. It is shown that the Balmer decrement can be interpreted as being produced by recombination with a small contribution of collisional excitation. The continuum intensities indicate an additional source of continuum beyond that produced purely by radiative recombinations, and it is suggested that collisional excitation of the hydrogen 2s level is a likely mechanism for production of the additional continuum. Temperatures derived from [O III] line intensities are in the range of 39,000° to 49,000° K, while [O II], [N II], and [S II] line intensities give temperatures from 8400° to 17,400° K. Electron densities derived from [O II] line intensities are 100-275 cm^{-3}, and from [S II] line intensities are 520-1500 cm^{-3}. Comparison with theoretical calculations of the structure of a radiating shock by Cox shows excellent quantitative agreement for two of the positions observed, but for the third the agreement is poorer. (auth)

13460 QSO ENVELOPES: OPTICALLY THIN, LOW DENSITY, AND NORMAL ABUNDANCES? Scargle, J.D. (Lick Observatory, Board of Studies in Astronomy and Astrophysics, University of California, Santa Cruz); Caroff, L.J.; Tarter, C.B. Astrophys. J. 189: No. 2, 181-186 (15 Apr 1974).

We consider the family of photoionization models which are optically thin to the ionizing radiation, have low enough density that collisional de-excitation is unimportant, and have normal (cosmic) chemical abundances. The line ratios from all such models with a given form of the ionizing spectrum can be derived by means of a scaling law from a single numerical calculation and expressed as a function of one physical parameter. The value of the parameter is uniquely determined from the observed line ratios. The resulting model is in reasonably good agreement with the typical or composite QSO spectrum and with line intensities for two recently observed individual QSOs. We therefore suggest that much of the emission may come from optically thin gas, although some of the observational evidence (especially the strength of Mg II λ2800) indicates that thick gas may also be present in some objects. (auth)

13461 AN UNUSUAL X-RAY SOURCE IN SCUTUM. Hill, R.; Burginyon, G.; Grader, R.; Toor, A.; Stoering, J.; Seward, F. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). Astrophys. J. Lett. 189: No. 2, L69-L70 (15 Apr 1974).

Two previously unreported X-ray sources have been observed. The spectrum of one of them, Sct X-1 ($l^{II}=24^{\circ}.41$), shows the strongest absorption of any source that we have ever observed. Both sources are probably variable. (auth)

13462 OBSERVATIONS OF Hα IN HDE 226868. Brucato, R.J.; Zappala, R.R. (Hale Observatories, Carnegie Institution of Washington,

California Institute of Technology). Astrophys. J. Lett. 189: No. 2, L71-L74 (15 Apr 1974).

High-dispersion spectrograms in the red have been obtained for HDE 226868, the optical candidate for Cyg X-1. Emission is present at Hα which varies systematically with the binary period, and apparently originates in the vincinity of the B supergiant. During the period of observation a broad redshifted emission component was present throughout the cycle at a velocity of about +200 km s^{-1} with respect to the primary, while a similar blueshifted component appeared at -200 km s^{-1} between photometric phases 0.2 and 0.6. (auth)

13463 PHOTOELECTRIC SPECTROPHOTOMETRY OF OQ 172 AND OH 471. Oke, J.B. (Hale Observatories, California Institute of Technology, Carnegie Institution of Washington). Astrophys. J. Lett. 189: No. 2, L47-L49 (15 Apr 1974).

Absolute spectral energy distributions for the large-redshift quasars OQ 172 and OH 471 are discussed along with similar data for two other quasars: 4C 05.34 and PHL 957. If the redshifts are assumed to be cosmological, OQ 172 and OH 471 are not as luminous as PHL 957. If these quasars are basically similar and if radiative processes dominate, the strength of Lα and the behavior of the continuum at the Lyman limit strongly suggest that these objects consist of a central ionizing source surrounded by discrete clouds, filaments, or a gaseous structure such as a disk. This gaseous matter does not cover the whole solid angle surrounding the source. (auth)

13464 ON THE NATURE OF THE UNIDENTIFIED HIGH-LATITUDE UHURU SOURCES. Holt, S.S.; Boldt, E.A.; Serlemitsos, P.J. (Laboratory for High Energy Astrophysics, Goddard Space Flight Center, Greenbelt, Maryland); Murray, S.S.; Giacconi, R.; Kellogg, E.M.; Matilsky, T.A. Astrophys. J. Lett. 188: No. 3, L97-L101 (15 Mar 1974).

It is found that the unidentified high-latitude Uhuru sources can have either of two very different explanations. They must either reside at great distances with luminosity $\gtrsim 10^{46}$ ergs s^{-1}, or be contained in the Galaxy with luminosity $\lesssim 10^{34}$ ergs s^{-1}. The two possibilities are indistinguishable with the available data. (auth)

13465 DETECTION OF THE [Fe XIV] CORONAL LINE AT 5303 Å IN THE CYGNUS LOOP. Woodgate, B.E.; Stockman, H.S. Jr. (Columbia Astrophysics Laboratory, Columbia University); Angel, J.R.P.; Kirshner, R.P. Astrophys. J. Lett. 188: No. 3, L79-L82 (15 Mar 1974).

Emission in the [Fe XIV] coronal line at 5303 Å has been detected in strong X-ray emitting regions of the Cygnus Loop. For the strongest region the flux measured was $(7.1\pm1.2)\times10^{-12}$ ergs $(cm^2 s)^{-1}$, giving an average brightness of $(3.1\pm0.5)\times10^{-4}$ ergs $(cm^2 s\ sr)^{-1}$ in the 1°.0 diameter field of view used, a result different from zero by 6 standard deviations. These fluxes agree well with calculations based on a thermal model for X-ray emission with normal iron abundance. Upper limits to fluxes in the line were obtained for the center of the Cygnus Loop and for Puppis A and IC 443. (auth)

13466 A LARGE CARBON MONOXIDE CLOUD IN ORION. Tucker, K.D.; Kutner, M.L.; Thaddeus, P. (Goddard Institute for Space Studies, New York City). Astrophys. J. Lett. 186: No. 1, L13-L17 (15 Nov 1973).

Carbon monoxide line emission at λ=2.6 mm has been observed over an area of ~½° × 4° in L1630, a diffuse dark nebula bridging NGC 2024 and the reflection nebula NGC 2068. The absence of a 21-cm counterpart to this region of high visual extinction suggests that L1630 is mainly molecular hydrogen. The H_2 is estimated from the carbon monoxide observations to be $2.5\times10^4 \lesssim M \lesssim 1\times10^5 M_\odot$, a significant fraction of the total mass of stars and gas within the boundaries of the I Ori association. (auth)

13467 OBSERVATION OF THE J=2 TO J=1 TRANSITION OF INTERSTELLAR CO AT 1.3 MILLIMETERS. Phillips, T.G.; Jefferts, K.B. (Bell Laboratories, Murray Hill, New Jersey); Wannier, P.G. Astrophys. J. Lett. 186: No. 1, L19-L22 (15 Nov 1973).

We report the observation of 1.3-mm line radiation from interstellar sources due to the J=2-1 transitions of $^{12}C^{16}O$ and $^{13}C^{16}O$. The Orion Nebula CO system is found to be thermalized and to show a peak excitation temperature of approximately 76°K. (auth)

13468 A VERY LARGE LIGHT PULSE FROM THE OBJECT IDENTIFIED WITH PKS 0537—441. Eggen, O.J. (Mount Stromlo and Siding Spring Observatory, Research School of Physical Sciences, The Australian National University). Astrophys. J. Lett. 186: No. 1, L1-L2 (15 Nov 1973).

The object identified with PKS 0537—441 shows light variations with an amplitude near 4 mag. (auth)

13469 MODELS OF VRO 42.22.01 (BL Lacertae). Andrew, B.H. (National Research Council of Canada, Ottawa). Astrophys. J. Lett. 186: No. 1, L3-L6 (15 Nov 1973).

Recent long-baseline observations of VRO 42.22.01 (BL Lac) are combined with observations of the total flux density. It is shown that the behavior of the source is compatible with a model of variable radio sources similar to that proposed by Ozernoy and Sazonov. Furthermore, the observations cannot exclude a model composed of a number of static components flaring at random. (auth)

13470 THE NATURE OF CYGNUS X-3: A PROTOTYPE FOR OLD POPULATION BINARY X-RAY SOURCES. Davidsen, A. (Astronomy Department and Space Sciences Laboratory, University of California, Berkeley); Ostriker, J.P. Astrophys. J. 189: No. 2, 331-338 (15 Apr 1974).

We present a model for Cyg X-3 based on a short-lived phase in the evolution of a U Geminorum-type binary where rapid mass transfer and mass loss occurs. X-rays are generated by accretion on the white dwarf component, while both stars are enveloped in a thick stellar wind emanating from the red dwarf. Electron scattering in the cloud is responsible for the modulation of the X-rays with the orbital period of 4.8 hours. Ultraviolet radiation and low-energy X-rays absorbed in the cloud are reradiated in the optical and infrared, which, it is predicted, will display a 4h.8 modulation in phase with the X-ray light curve. The X-ray absorption cutoff should also vary with phase, appearing at minimum energy when the source is at maximum light. The model also provides a framework in which certain aspects of the associated nonthermal radio source may be understood. Finally, we suggest that the model may be applicable to Sco X-1 as well. (auth)

13471 LONG-TERM OBSERVATIONS OF CYGNUS X-2 FROM OSO-7. Ulmer, M.P.; Sammuli, A.; Baity, W.A.; Wheaton, W.A.; Peterson, L.E. (University of California, San Diego, La Jolla, California 92037). Astrophys. J. 189: No. 2, 339-341 (15 Apr 1974).

This paper reports the results of observations of Cyg X-2 made with the UCSD OSO-7 X-ray telescope during the intervals 1972 January 9-16, 1972 January 21-26, and 1972 July 8-11. Random factor-of-two variations were found in the data. The average flux over the ~7-18 keV range was 0.093 ±0.003 photons cm^{-2} s^{-1}, and the 2σ upper limit in the 18-47 keV range was 0.012 photons cm^{-2} s^{-1}. The energy spectrum could be fitted with an exponential $I=Ne^{-E/kT}$ with $3\lesssim kT\lesssim 10$ keV. (auth)

13472 MEASUREMENTS OF THE CRAB PULSAR AT 2.2 AND 3.5 MICRONS. Becklin, E.E.; Kristian, J. (Hale Observatories, California Institute of Technology, Carnegie Institution of Washington); Matthews, K.; Neugebauer, G. Astrophys. J. Lett. 186: No. 3, L137-L140 (15 Dec 1973).

The light curve of NP 0532 is shown to be the same at 2.2 μ as at visible wavelengths when observed with millisecond time resolution. The energy density in the main pulse at 2.2 μ is $4.5\pm0.4\times10^{-31}$ J m^{-2} Hz^{-1}. (auth)

13473 OBSERVATIONS OF THE CRAB NEBULA AT 73.8 MHz. Armstrong, J.W.; Coles, W.A.; Kaufman, J.J.; Rickett, B.J. (Department of Applied Physics and Information Science, University of California, San Diego). Astrophys. J. Lett. 186: No. 3, L141-L144 (15 Dec 1973).

Interplanetary-scintillation observations at 73.8 MHz show that 14±2 percent of the flux of the Crab Nebula is contained in a compact source of Gaussian shape with a diameter (at e^{-1}) of 0°.18±0°.01. This is twice the average pulsar flux extrapolated from VLBI observations. (auth)

13474 EFFECT OF FARADAY ROTATION ON THE CIRCULAR POLARIZATION OF THE CRAB NEBULA. Gerver, M.J. (Physics Department, University of California, Berkeley, California 94720). Astrophys. J. 189: No. 2, 249-252 (15 Apr 1974).

The effect of Faraday rotation on the circular polarization of an electromagnetic wave propagating through a magnetized plasma is calculated for various limits of the plasma and wave parameters appropriate to a 30-Hz wave in the Crab Nebula. It is shown that a static magnetic field of the proper geometry and only a few times stronger than the wave field can reduce the circular polarization of the nonlinear inverse Compton radiation to a value below the observed upper limit. (auth)

13475 DETECTION OF RADIO RECOMBINATION-LINE EMISSION FROM THE RHO OPHIUCHI DARK CLOUD. Brown, R.L. (National Radio Astronomy Observatory, Green Bank, West Virginia); Knapp, G.R. Astrophys. J. 189: No. 2, 253-258 (15 Apr 1974).

Recombination-line observations in the direction of the ρ Oph dark cloud at 21 cm are described in which we have detected the carbon 166α and 167α lines. The excellent agreement between the velocity of these lines and the velocity of molecular lines from the ρ Oph cloud lead to an unequivocal identification of the regions of recombination-line emission with the dark cloud itself. The velocity width of the recombination lines $\Delta v=2.4$ km s^{-1} is comparable with the widths of the CO and OH lines, indicating that the line must arise in cold gas. The emission measure of the line, ~0.2 cm^{-6} pc, is sufficiently large as to require that the line originate in regions with densities $n>650$ cm^{-3}. From these observations, together with an analysis of the H I self-absorption feature seen in the same direction, we infer that the

relative electron density in the line-emitting regions of the cloud is $n_e/n \leq 1.6 \times 10^{-4}$. (auth)

13476 ON THE VELOCITY STRUCTURE OF THE INTERSTELLAR CLOUDS NEAR RHO OPHIUCHI. Cohen, J.G. (Kitt Peak National Observatory, Tucson, Arizona); Wallerstein, G. Astrophys. J. 189: No. 2, 259-261 (15 Apr 1974).

Accurate radial velocities of the optical interstellar features for some of the B stars embedded in the ρ Oph complex are obtained by averaging results of several photographic high-dispersion spectra. In at least one case, there is a real difference between the radial velocity of the atomic features (Na I and Ca II) and the molecular ones (CH and CN). We show that it is probable that the CH and CN are concentrated either in a separate cloud (i.e., region of space) from the Ca II and Na I or in a cloud whose outer parts are expanding rather than in a single cloud which is contracting or rotating. (auth)

13477 UPPER LIMITS TO THE HIGH-ENERGY X-RAY FLUX FROM 16 X-RAY SOURCES AND 10 PULSARS. Ricker, G.R.; Gerassimenko, M.; McClintock, J.E.; Ryckman, S.G.; Lewin, W.H.G. (Center for Space Research and Department of Physics, Massachusetts Institute of Technology). Astrophys. J. Lett. 186: No. 3, L111-L114 (15 Dec 1973).

On 1972 April 5–6, we carried out balloon X-ray observations from Australia. From these observations we have derived upper limits to the flux (in the energy range above 17 keV) from 16 Uhuru sources and 10 radio pulsars, including the Vela pulsar (PSR 0833–45). (auth)

13478 DISCOVERY OF A CENTRAL X-RAY OBJECT IN THE CYGNUS LOOP. Rappaport, S.; Cash, W.; Doxsey, R.; Moore, G. (Physics Department and Center for Space Research, Massachusetts Institute of Technology); Borken, R. Astrophys. J. Lett. 186: No. 3, L115-L118 (15 Dec 1973).

A new X-ray surface-brightness map of the Cygnus Loop reveals the presence of a centrally located "hot spot." This central feature has a distinctly harder spectrum than the outer diffuse regions of the Loop, is less than 30′ in angular extent, and quite possibly is pointlike. The location of the centroid of this feature, α (1950) = $20^h49.7^m$, δ (1950) = +30°43′, is within a few arc minutes of the Loop center. This object, which may be the stellar remnant of the supernova explosion, accounts for 4 percent of the detected photon flux from the entire Loop and has an energy spectrum consistent with a blackbody of $\sim 2 \times 10^6$°K. Recent radio searches for this central source by other groups have yielded only upper limits. A search for periodic X-ray pulsations from this object revealed one possibly statistically significant frequency component corresponding to a 62-ms period. (auth)

13479 SPECTROSCOPIC OBSERVATIONS OF THE OPTICAL COMPANION TO CENTAURUS X-3. Rickard, J.J. (European Southern Observatory, Santiago, Chile). Astrophys. J. Lett. 189: No. 3, L113-L115 (1 May 1974).

Image-tube spectra of the optical companion of Cen X-3 have been used to estimate its spectral type to be O9.5–B0.5 Ib. Its distance is calculated to be 10 kpc, which is consistent with the observed E(B–V), the strengths of interstellar features and the 21-cm H I column density in the direction toward the star. The column density is of the order of 5×10^{21} atoms cm^{-2}. The soft X-ray observed from Cen X-3 and the model proposed by Bleeker et al. are probably inconsistent with such a large amount of interstellar matter. Two possible solutions to this problem are suggested. (auth)

13480 AN UPPER LIMIT ON SOFT X-RAY PULSATIONS FROM THE PULSAR PSR 0833–45. Moore, W.E.; Agrawal, P.C.; Garmire, G. (California Institute of Technology, Pasadena). Astrophys. J. Lett. 189: No. 3, L117-L118 (1 May 1974).

A soft X-ray observation of the pulsar PSR 0833–45 places a 2 σ upper limit of 0.3 percent on the fraction, relative to the flux from the entire Vela X Nebula, of pulsed flux in the 0.5- to 1.0-keV energy band. This limit is approximately a factor of 7 below the value observed by Harnden and Gorenstein. (auth)

13481 DETECTION OF PULSAR PROPER MOTION. Manchester, R.N.; Taylor, J.H.; Van, Y.Y. (Department of Physics and Astronomy, University of Massachusetts, Amherst). Astrophys. J. Lett. 189: No. 3, L119-L122 (1 May 1974).

Proper motion has been detected for PSR 1133+16 by means of pulse arrival-time observations made over a 4-year period. The observed value of $\mu = 0''.58 \pm 0''.22$ yr^{-1} implies a transverse pulsar velocity of 380 km s^{-1} for an assumed distance of 130 pc. (auth)

13482 THE PHOTOMETRIC HISTORY OF THE OBJECT IDENTIFIED WITH PKS 0537–441. Liller, W. (Center for Astrophysics, Harvard College Observatory and Smithsonian Astrophysical Observatory, Cambridge, Massachusetts). Astrophys. J. Lett. 189: No. 3, L101-L102 (1 May 1974).

Harvard photographs reveal that since 1892 the B-magnitude of the object identified with PKS 0537–441 has fluctuated erratically between 12.6 and 16.5 with peak brightnesses coming in 1917 and in 1944–1945. If any long-term periodicity exists, a maximum brightness should have occurred in late 1972. There may also be a 60-day periodicity. (auth)

13483 ON THE PASSAGE OF RADIATION THROUGH INHOMOGENEOUS, MOVING MEDIA. III. THE STEADY-STATE FIELDS OF INERTIAL CHARGE DISTRIBUTIONS. Lerche, I. (Enrico Fermi Institute and Department of Physics, University of Chicago, Chicago, Illinois). Astrophys. J. 188: No. 3, 627-635 (15 Mar 1974).

Motivated by the conjectures that the differentially shearing magnetospheres of pulsars are responsible for the observed pulsed-radiation production, we have investigated as simply as possible the basic physics and topology of electric field lines emanating from an inertial charge distribution embedded in a differentially shearing medium. For the two simple cases of a uniformly charged rod and a uniformly charged plate we compute, and sketch, the basic field-line patterns. We believe that the results of these two simple cases are sufficient to show that our knowledge of the basic physics of radiation generation and transport in differentially shearing media is, at best, fragmentary. Accordingly we do not yet see how to construct a physically correct model for pulsed-radiation production and propagation in the differentially shearing magnetospheres of pulsars. (auth)

13484 CORRELATION ANALYSIS OF X-RAY EMISSION FROM CYGNUS X-1. Brinkman, A.C.; Parsignault, D.R.; Schreier, E.; Gursky, H.; Kellogg, E.M.; Tananbaum, H.; Giacconi, R. (American Science and Engineering, Cambridge, Massachusetts). Astrophys. J. 188: No. 3, 603-608 (15 Mar 1974).

Normalized autocorrelation and cross-correlation coefficients have been calculated for the X-ray emission of Cygnus X-1 in two energy bins, 2.1–5.1 keV and 5.1–12 keV. The analysis shows a strong correlation between the pulsations in the two energy bins, with the low-energy pulsations lagging behind the high-energy ones, or alternatively a shorter duration of the pulse trains in the high-energy bin. The power spectral density derived from the autocorrelation functions indicates a larger contribution of the high-frequency components for the higher-energy X-rays. (auth)

13485 INDIVIDUAL PULSE POLARIZATION PROPERTIES OF THREE PULSARS. Rankin, J.M. (Department of Physics and Astronomy, University of Iowa, Iowa City); Campbell, D.B.; Backer, D.C. Astrophys. J. 188: No. 3, 609-613 (15 Mar 1974).

Both average and individual pulse polarization measurements at 430 MHz are presented for three pulsars: PSR 0823+26, PSR 0834+06, and PSR 2303+30. In each case the average Stokes parameter wave forms are found to depend on the individual pulse polarization properties in a complicated manner. The average wave forms are in general depolarized by pulse-to-pulse fluctuations in polarization state at a given longitude. Two of the three objects exhibit variations of both linear and circular polarization which are associated with quasi-periodic subpulse modulation phenomena in a manner similar to that reported for linear polarization in PSR 0809+74 by Taylor et al. (auth)

13486 SPECTROPHOTOMETRIC OBSERVATIONS OF THE COMPACT H II REGION K3-50 AND OF NGC 6857. Persson, S.E.; Frogel, J.A. (Center for Astrophysics, Harvard College Observatory and Smithsonian Astrophysical Observatory). Astrophys. J. 188: No. 3, 523-527 (15 Mar 1974).

Spectrophotometric observations of K3-50 from 0.5 to 1.1 μ demonstrate that there is a discrepancy between the values of the interstellar extinction determined from radio, infrared, and optical measurements. The optically determined value for the visual absorption A_v is 8.3 mag, considerably less than the values derived by comparing the Hα or 1.65-μ flux with the 10-GHz flux. A model consistent with the data involves spatially varying extinction which affects one or more sources unequally. The region K3-50 also has a prominent optical continuum which is interpreted as arising from an early-type star or stars. The bolometric luminosity of this star is shown to be comparable to the far-infrared luminosity of K3-50. Similar observations of the nearby nebula NGC 6857 show that it differs in several respects from K3-50. In particular, the extinction toward NGC 6857 is considerably less than that observed toward K3-50. (auth)

13487 ABUNDANCES IN THE CRAB NEBULA. Davidson, K. (Prince University Observatory). Astrophys. J. 186: No. 1, 223-231 (15 Nov 1973).

The bright visual-wavlength emission lines in spectra of filaments in the Crab Nebula cannot be used to derive unique values for the relative abundances of elements there, even under a simplifying assumption that heating is due entirely to photoionization by the Crab's nonthermal continuum. However, a range of possibilities may be estimated. By mass, helium is more abundant than hydrogen; but the mass fraction of heavier elements may be surprisingly small. Such conclusions are subject to modification if a noticeable fraction of the energy density involves fast particles around 1 MeV. (auth)

13488 X-RAY EMISSION FROM A NEUTRON STAR ACCRETING MATERIAL. Alme, M.L.; Wilson, J.R. (Lawrence Livermore Laboratory, University of California). Astrophys. J. 186: No. 3, 1015-1025 (15 Dec 1973).

Computer calculations of the X-ray emission resulting from the accretion of material onto a neutron star have been performed. For

high-mass neutron stars, the emitted spectra differ only slightly from blackbody spectra, particularly at lower luminosities. For low-mass neutron stars, the spectra differ greatly from blackbody spectra at all luminosities. (auth)

13489 INFRARED VARIABILITY AND THE INTERSTELLAR REDDENING OF THE X-RAY SOURCE HD 77581. Hyland, A.R.; Mould, J.R. (Mount Stromlo and Siding Spring Observatory, Research School of Physical Sciences, Australian National University). Astrophys. J. 186: No. 3, 993-996 (15 Dec 1973).

HD 77581 is a bright B supergiant whose companion has been identified with the X-ray source 2U 0900-40. Small variations of the K-magnitude have been observed which are comparable with the visual light curve. The intrinsic infrared colors corrected for interstellar reddening alone are typical of a normal B supergiant; no evidence is found for excess infrared radiation out to 3.6 μ. The nature and extent of the interstellar reddening are consistent with the high luminosity and mass previously derived for HD 77581 and HD 153919. (auth)

13490 HEATING OF MOLECULAR-HYDROGEN CLOUDS BY COSMIC RAYS AND X-RAYS. Glassgold, A.E.; Langer, W.D. (Department of Physics, New York University, New York City). Astrophys. J. 186: No. 3, 859-888 (15 Dec 1973).

We calculate the heating of molecular clouds, whose main constituent is H_2, by low-energy cosmic rays and soft X-rays. The heating of molecular hydrogen is qualitatively different from the atomic-hydrogen case because of vibrational and rotational excitation modes and dissociation. We discuss these properties and determine how the heat is deposited by the primary ionization and by secondary and higher-generation electrons. We find that at zero electron concentration a 2-MeV proton produces ~15 eV of heating after an ionization of H_2 in which it loses ~35 eV. For a fractional electron concentration of 10^{-3}, which probably is an upper limit for molecular clouds, this heating is 17 eV. For X-rays we find that ~35 percent of the initial energy is effective in heating the gas. Above 100 eV, each absorbed X-ray produces approximately $25(E_\gamma/\text{keV})$ electrons. The additional effects arising from the presence of helium are included, and lead to an increase in the heating and the primary ionization rate by a factor of 3 for X-rays. (auth)

13491 A RADIO RECOMBINATION LINE IN THE SPECTRUM OF W44. Bignell, R.C. (National Radio Astronomy Observatory, Green Bank, West Virginia). Astrophys. J. 186: No. 3, 889-898 (15 Dec 1973).

A H166α recombination line was found in the continuum spectrum of W44 and in the weak galactic emission about three-quarters of a degree away. The lines are weak, but there is a difference in their structure. The recombination-line parameters are compared with the neutral hydrogen and molecular line parameters. It is suggested that the supernova explosion of W44 may be responsible for ionizing the gas which is emitting the H 166α line. This possibility is discussed; however, it is concluded that due to insufficient observations, emission from diffuse gas not associated with W44 or from an H II region that has line-of-sight coincidence with W44 cannot be ruled out. The absence of H 166α absorption or stimulated emission is used to estimate upper limits to the ionization rate of the gas in front of W44. These limits are compatible with other published estimates of the ionization rate of the interstellar material. (auth)

13492 ON THE PROBLEM OF EXPLAINING DECIMETER FLUX VARIATIONS IN 3C 454.3 AND OTHER EXTRAGALACTIC SOURCES. Jones, T.W.; Burbridge, G.R. (Department of Physics, University of California, San Diego). Astrophys. J. 186: No. 3, 791-799 (15 Dec 1973).

Attempts to understand flux variations at 408 MHz of the QSO 3C 454.3 and other extragalactic radio sources are described. If 3C 454.3 is at a cosmological distance (luminosity distance ~5000 Mpc), the variations have occurred on a time scale ~1/50 of the light travel time across the source. For this source it is shown that models utilizing moving "searchlight images" or small spatially independent sources are implausible. Expanding source models probably can be made to account for the variations. However, if the source is at a cosmological distance, the expansion velocity must be 0.9998c and it is necessary to mock up an inhomogeneous model which gives the appearance of a source expanding nonrelativistically. There are also serious problems associated with understanding how such a highly energetic relativistic cloud is not showed down by the matter giving rise to the optical emission-line spectrum of this QSO, thereby giving rise to large changes in the line spectrum. The simplest way of explaining the observations is to suppose that the source is at a distance ≤100 Mpc, since in this case a cloud expanding nonrelativistically is adequate. It is shown that these arguments can be applied to CTA 102 and other sources which vary on time scales of years in this frequency range. (auth)

13493 EXTRAGALACTIC RADIO SOURCES: ACCURATE POSITIONS FROM VERY-LONG-BASELINE INTERFEROMETRY OBSERVATIONS. Rogers, A.E.E.; Counselman, C.C. III; Hinteregger, H.F.; Knight, C.A.; Robertson, D.S.; Shapiro, I.I.; Whitney, A.R. (Massachusetts Institute of Technology, and Haystack Observatory, Cambridge and Westford, Massachusetts); Clark, T.A. Astrophys. J. 186: No. 3, 801-806 (15 Dec 1973).

Relative positions for 12 extragalactic radio sources have been determined via wide-band very-long-baseline interferometry (λ≃3.8 cm). The standard error, based on consistency between results from widely separated periods of observation, appears to be no more than 0".1 for each coordinate of the seven sources that were well observed during two or more periods. The uncertainties in the coordinates determined for the other five sources are larger, but in no case exceed 0".5. (auth)

13494 ON THE EVOLUTION OF SUPERNOVA REMNANTS. I. EVOLUTION OF THE MAGNETIC FIELD, PARTICLES, CONTENT, AND LUMINOSITY. Pacini, F. (Laboratorie Di Astrofisica Spaziale, Frascati, Italy); Salvati, M. Astrophys. J. 186: No. 1, 249-265 (15 Nov 1973).

We investigate the evolution of supernova remnants by assuming that a central pulsar keeps injecting magnetic energy and relativistic particles. Taking into account expansion losses, we can describe the evolution of the nebular magnetic field. The predicted field for the Crab Nebula is about 10^{-3} gauss, in agreement with a recent determination. Assuming that the continuous injection of particles follows a power-law spectrum, we investigate the evolution of the energy spectrum for the nebular particles and the resulting synchrotron luminosity., (auth)

13495 INTERSTELLAR CS: OBSERVATIONS OF NEW TRANSITIONS AND ISOTOPIC SPECIES, AND A STUDY OF ITS EXCITATION. Turner, B.E. (National Radio Astronomy Observatory, Charlottesville, Virginia); Zuckerman, B.; Palmer, P.; Morris, M. Astrophys. J. 186: No. 1, 123-147 (15 Nov 1973).

The J=1-0 and 2-1 transitions of $^{12}C^{32}S$, $^{12}C^{34}S$, and $^{12}C^{33}S$ have been observed in interstellar sources. CS is often observed in the direction of infrared sources, and is quite widespread in occurrence, with typical projected densities of 10^{14} cm^{-2}. The strongest sources of CS are those of strongest emission in other molecules at millimeter wavelengths (HCN, CO, U89.2) and lie in the general direction of the brightest H II regions. CS was also detected in new regions apparently associated with far-infrared sources, which include NGC 2264, H2-3, W3, NGC 7538, R CrA, and some regions near the galactic center. The 1-0 transition of CS has also been detected in at least one optically dark dust cloud. If the abundance ratio CS/H_2CO is similar in dark clouds and in infrared/H II region clouds, it is possible to deduce firm upper limits for the total density in several dark dust clouds (typically $n_{H2} < 4\times10^4$cm^{-3}). Isotopic abundance ratios of carbon and sulfur appear to have terrestrial values, with the exception that in the galactic-center region the $^{12}C/^{13}C$ ratio may be only about half the terrestrial value. Present analysis suggests that the excitation of interstellar CS can in most cases be explained by collisions obeying dipole selection rules. Assuming statistical equilibrium, the populations of the CS energy levels are calculated including the effects of collisions, a blackbody radiation field, and spontaneous emission. When the hard-sphere collisions obey no selection rules, population inversions can occur in the lower transitions. (This situation does not appear necessary to explain the observations in most sources, and can probably be ruled out in some of them.) Infrared pumping to the first excited vibrational state could also be important, and may produce certain anomalies in the ground-state populations. (auth)

13496 THE LUMINOSITY FUNCTION OF GALACTIC X-RAY SOURCES: A CUTOFF AND A "STANDARD CANDLE"?. Margon, B. (Space Sciences Laboratory and Astronomy Department, University of California, Berkeley); Ostriker, J.P. Astrophys. J. 186: No. 1, 91-96 (15 Nov 1973).

We analyze the 2-10 keV luminosity distribution of 36 X-ray sources in the Local Group having known or estimated distances and find that there exists a luminosity cutoff of approximately $10^{37.7}$ ergs s^{-1} in agreement with the theoretical (Eddington) limit for the luminosity of an approximately 1 $M_\odot$ star. Furthermore, among the complete sample of high-luminosity sources, there appears to be a statistically significant group of X-ray "standard candles" at (within <0.8 mag) the critical luminosity. This finding (which is in agreement with the self-consistent mass flow accretion models) presents the possibility that X-ray sources may be used as extragalactic distance indicators in the next generation of X-ray astronomy experiments. (auth)

13497 PULKOVO OBSERVATIONS OF CYGNUS A AT 2.04 CM. Mirovskii, V.G.; Soboleva, N.S.; Strukov, I.A.; Fridman, P.A. (Central Astronomical Observatory, Academy of Sciences of the USSR, Pulkovo). Sov. Astron.-AJ 17: No. 5, 571-573 (Mar 1974).

Observations of the radio source Cyg A with the large Pulkovo radio telescope at λ=2.04 cm are reported (receiver sensitivity, 0.03°K; time constant, 1 sec, passband ≃1000 MHz). The magnetic field of each component is found to be nonuniform in the plane of the sky, with a looped field structure. The electron density in the components is lower than 10^{-5} cm^{-3}. (auth)

13498 BEAM PATTERN OF AN x-RAY PULSAR. Bisnovatyi-Kogan, G.S. (Institute of Applied Mathematics, Academy of Sciences of the USSR, Moscow). Sov. Astron.-AJ 17: No. 5, 574-576 (Mar 1974).

An analysis is given of the accretion of matter by a neutron star with a strong dipole magnetic field B, where the influx proceeds along the field lines, forming hot spots at the poles. The electron momentum distribution will be anisotropic, with $p_\parallel^2 \gg p_\perp^2$, and the dependence of the anisotropy on the magnetic field is evaluated. If $B = 10^9$–10^{10} gauss the radiation from the poles will be highly directional, exhibiting a pencil-beam pattern. (auth)

13499 PHYSICAL CONDITIONS IN CASSIOPEIA A. Bychkov, K.V. (Special Astrophysical Observatory, Academy of Sciences of the USSR). Sov. Astron.–AJ 17: No. 5, 577-584 (Mar 1974).

When the envelope of the Cas A nebula compresses its steady filaments a shock wave is generated, producing emission consistent with the observations. The filaments are found to be several times less massive than previously estimated. Possible mechanisms for the decay of the filaments are discussed. Their spectrum can be explained by assuming a normal chemical composition. The nonsteady filaments (moving knots) emit [O II] and [O III] when a growing shock wave develops within them as the nebula decelerates. Moving forward, the knots proceed to stretch out the frozen-in field lines joining them to the nebular plasma. This field accelerates the shock, whose advance ultimately ceases. The brightness variability of the knots is explained in a natural fashion. The [O I] and [S II] emission might result from gradual attenuation of the shock because of a density gradient in the knots, but it could be unrelated to the shock wave. It is entirely possible that the moving knots are heated and partially ionized by masses of hot gas, whose presence in the nebula does not conflict with observation, and is in fact required dynamically. Some observational tests of these alternatives are outlined. The spectroscopic peculiarities of the knots can be explained with a normal hydrogen abundance but a deficiency of nitrogen. The relation between the moving knots and the synchrotron radiation of the nebula is discussed. (auth)

13500 RADIO-SOURCE COUNTS AT $\nu = 86$ MHz. II. STATISTICAL DETERMINATION OF THE (log N, log S) RELATION. Artyukh, V.S.; Vitkevich, V.V.; Dagkesamanskaya, I.M. (Lebedev Physics Institute, Academy of Sciences of the USSR). Sov. Astron.–AJ 17: No. 5, 588-593 (Mar 1974).

A field in the sky has been surveyed at 86-MHz frequency with the east-west array of the DKR-1000 radio telescope in order to investigate the behavior of the radio-source count curve at low flux densities. The records were reduced by techniques described previously. A statistical analysis of the observations shows that to obtain agreement with Gower's count curve at 178 MHz, the mean spectral index for 86–178 MHz should exhibit a dependence on flux density S for low S analogous to that found by Dagkesamanskii. (auth)

13501 EFFECT OF REFRACTION ON SCINTILLATION CHARACTERISTICS AND AVERAGE PULSE SHAPE OF PULSARS. Shishov, V.I. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR). Sov. Astron.–AJ 17: No. 5, 598-602 (Mar 1974).

The scintillations of pulsars on interstellar plasma heterogeneities which have two characteristic scales of heterogeneity a_1 and $a_2 \gg a_1$ are considered. Conditions for the formation of saturated (strong) scintillations are provided by heterogeneities with dimension a_1, while heterogeneities with dimension a_2 do not give rise to amplitude modulation and are only manifested through the effect of refraction. The extent of the medium and the sphericity of the waves are taken into account in all the calculations. Expressions are obtained for the frequency-time correlation function of intensity fluctuations and for the average pulse shape produced by scattering in the interstellar medium. The theoretical results are compared with experimental data; in particular, the effect of refraction explains the observed effect of frequency drift of the scintillation pattern. The characteristic dimension a_2 of the heterogeneities is estimated to be about 10^{14}–10^{15} cm. (auth)

13502 INTERFEROMETRY OF THE SUPERNOVA REMNANT W28. Lozinskaya, T.A. (Shternberg Astronomical Institute, Moscow). Sov. Astron.–AJ 17: No. 5, 603-606 (Mar 1974).

Detailed observations of W28 in the λ6563 Hα and λ6584 [N II] lines have been made with a Fabry-Perot interferometer and a contact electronic image converter. The actual spectral resolution corresponded to 20 km/sec. For observations with the 125- and 48-cm reflectors of the Shternberg Institute the angular resolution was 10′ and 25′. Twelve interferograms were obtained in λ6584 and 20 in Hα with exposures of 40–60 min. Expansion of the supernova remnant at a velocity of 40–50 km/sec was detected. The radial velocity of the object as a whole relative to the Local Standard of Rest is $+18 \pm 5$ km/sec. The supernova outburst must have occurred in a dense complex of gas and dust. The density of the undisturbed interstellar gas is $3 \cdot 10^{-22}$ g/cm^3, with most of the gas in the molecular state. The expansion velocity and Milne's radius of 6.5 pc imply that a kinetic energy $E = 3 \cdot 10^{50}$ ergs was released in ejecting the envelope, and that the age of the remnant is 60,000 yr. (auth)

13503 TEMPERATURE GRADIENT IN THE ORION NEBULA AND THE RECOMBINATION RADIO LINES. Pyatunina, T.B. Sov. Astron.–AJ 17: No. 5, 607-610 (Mar 1974).

By allowing for temperature and density gradients in the Orion Nebula, one can interpret the observations of recombination radio emission in all α lines and some higher-order lines without invoking departures from LTE. (auth)

Solar Phenomena

Refer also to abstract 13452.

13504 SOLAR X-RAY PHOTOGRAPHY WITH MULTIPLEX PIN-HOLE CAMERA. Blake, R.L.; Burek, A.J.; Fenimore, E.; Puetter, R. (Department of Astronomy and Astrophysics, Department of Physics, and Enrico Fermi Institute, The University of Chicago, Chicago, Illinois 60637). Rev. Sci. Instrum. 45: No. 4, 513-516 (Apr 1974).

A scatter-hole x-ray camera has been designed and flown in a rocket to measure solar x radiation. Its distinguishing feature is that many single pin-hole images are allowed to overlap—a multiplexing approach that saves space, gives practical signal-to-fog ratio, and requires special object reconstruction techniques. It was possible to reconstruct the appearance of the dominant source of solar emission on the day of rocket flight with better than one arc minute resolution. The coronal x-ray region had the same general shape and intensity distribution as the associated calcium K-line region. (auth)

13505 CHANGE IN CENTER-TO-LIMB PROFILES OF THE WEAK FRAUNHOFER LINES. III. Profile Shapes and Velocity Field. Gurtovenko, E. A. Astrometriya Astrofiz.; 19: 35-44 (1973). (In Russian).

Determination of the damping parameter, using the line profiles represented by the Voight function gives a value ten times greater than that calculated theoretically. It is suggested that a significant increase in velocities takes place in deeper layers and this causes the broadening of line wings and produces the spurious effect of a great value of the damping constant. The depth distribution of general "turbulent" velocity for different cos θ on the solar disk was obtained providing that the profiles are widened by the motion and thermal velocities only. The preliminary test scheme of the general field of photospheric velocities was constructed by means of the given data. (auth)

13506 EFFECT OF PROGRESSIVE SOUND WAVES ON THE PROFILES OF SPECIAL LINES. III. Shift of the Faint Fraunhofer Lines. Kostyk, R. I. Astrometriya Astrofiz.; 19: 44-54(1973). (In Russian).

The shift of faint Fraunhofer lines in a homogeneous medium with plane monochromatic progressive sound waves is found. It follows from the calculations that the lines of neutral atoms with low excitation potential $\chi_{ol} = 0$ to 2 eV are red shifted, with excitation potential $\chi_{ol} = 4$ to 7 eV—violet shifted, with $\chi_{ol} = 3$ eV—violet and red. The lines of ions are shifted toward the violet. The results of the calculations are in good agreement with observations. (auth)

13507 DETERMINATION OF THE MICROTURBULENT COMPONENT OF THE VELOCITY FIELD IN THE SOLAR PHOTOSPHERE. I. Application of the Method of Fine Analysis to the Line Lambda 6330 A CrI to Determine Microturbulent Velocity. Gerbil'skii, M. G.; Kondrashova, N. N. Astrometriya Astrofiz.; 19: 51-57(1973). (In Russian).

A method is described for theoretical computations of profiles of the Fraunhofer lines. Microturbulent velocities are derived by comparing the observed profile of the line Cr I λ 6330 Å with the computed one. The microturbulent velocity is found to be $v_t' = 3.5$ km/sec for $\mu = 1$, $v_t^0 = 8.0$ km/sec for $\mu = 0.28$. A depth dependence of the turbulent velocity is derived; v_t increases with depth. (auth)

13508 DETERMINATION OF THE MICROTURBULENT COMPONENT OF THE VELOCITY FIELD IN THE SOLAR PHOTOSPHERE. II. Microturbulent Velocity Derived by the Method of Fine Analysis, Using the Multiplet Lines. Kondrashova, N. N. Astrometriya Astrofiz.; 19: 57-63(1973). (In Russian).

The selected absorption lines of various formation conditions were recorded photoelectrically. Microturbulent velocities were derived by comparing the observed profiles with the computed ones. The anisotropic turbulent velocity was found to increase with depth. (auth)

13509 DETERMINATION OF THE NUMBER OF ATOMS IN ERUPTION PROMINENCES. Rudnikova, E. G. Astrometriya Astrofiz.; 19: 63-70(1973). (In Russian).

The curves of growth and the curves of half-widths of the H_α line were plotted for prominences consisting of fragments with different line-of-sight velocities. The shape of the half-width curves strongly depends on the motion character. The curves of growth with the curves of half-width plotted using the Balmer lines in the spectrum of eruptive prominence permit the number of

hydrogen atoms in the second quantum condition on the sight line and motion character to be determined. (auth)

13510 SPECTROPHOTOMETRY AND ANALYSIS OF INTENSIVE HYDROGEN AND CA II LINES IN THE SPECTRUM OF 30 CHROMOSPHERIC FLARES. Stembkovskaya, T. V.; Kurochka, L. N. Astrometriya Astrofiz.; 19: 70-80(1973). (In Russian).

This article deals with the results of the photometry of hydrogen emission lines H_α, H_β, H_ϵ as well as of H and K, Ca II lines in the spectrum of 32 chromospheric flares. The optical thicknesses, level populations and other flare parameters were obtained. (auth)

13511 ION CONTRIBUTION TO THE SCREENING EFFECT ON THERMONUCLEAR REACTIONS. Redkoborodyi, Yu. N. Astrometriya Astrofiz.; 19: 81-87(1973). (In Russian).

The screening effect of the Coulomb nuclei field is considered. Validity conditions of the theory are discussed. It is shown that the influence of ions has to be taken into consideration if $T \geq T_* = 10^9 \cdot A \cdot (Z_1 \cdot Z_2)^{2/3}$ K (A is a reduced mass of reacting nuclei Z_1 and Z_2 in a. u.). A method to account for the ion contribution at $T \geq T_*$ is proposed. This method combines the quantum theory for electron cloud with the statistical method (similar to the well-known Debye–Huckel method) for the screening ion cloud. It is shown that the ion contribution may be taken into account by means of introduction of the effective dielectric constant to the expressions for the electron screening effect. (auth)

13512 ABUNDANCES IN THE ATMOSPHERES OF M-TYPE SUPERGIANTS α SCO AND α HER A. Shavrina, A. V.; Yakovina, L. A. Astrometriya Astrofiz.; 19: 87-98(1973). (In Russian).

The relative abundances of some metals in the observable stage of ionization were obtained from the curve-of-growth analysis of high-dispersion spectrograms. The electron pressure was determined and the full number of atoms relative to Fe I was calculated. Comparison with the chemical composition of the Sun does not show appreciable difference. (auth)

13513 EFFECT OF PROGRESSIVE SOUND WAVE ON THE PROFILES OF SPECTRAL LINES. II. Asymmetry of Faint Fraunhofer Lines. Kostyk, R. I. Astrometriya Astrofiz.; 17: 50-54(1972). (In Russian).

The profile of the absorption coefficient was calculated for the lines of different chemical elements in a medium with progressive sound waves. It follows from the calculations that: 1) the degree and direction of asymmetry depend on atom ionization potentials and a potential lower level excitation of the individual line; 2) the degree of asymmetry of the line is found to decrease from the center of the solar disk to the limb; 3) turbulent motions "suppress" the asymmetry. (auth)

13514 INFLUENCE OF DEFLECTION FROM LOCAL THERMODYNAMIC EQUILIBRIUM ON GOLDBERG–UNNO METHOD. Troyan, V. I. Astrometriya Astrofiz.; 17: 54-59(1972). (In Russian).

The dependence of turbulent velocity ξ_t with a depth of $\tau^5_{(5000\ \text{Å})}$ was investigated, using Goldberg–Unno's method and taking into account the influence of deflection from LTE. It is found out that consideration of deflection from LTE displaces the dependence curve of turbulent velocity ξ_t on $\tau^5_{(5000\ \text{Å})}$ along both the axis ξ_t ($\Delta\xi_t \simeq 1.5$ km/sec and axis $\tau^5_{(5000\ \text{Å})}$ ($\Delta\tau^0 \simeq 0.05$). (auth)

13515 LUMINOSITY CONDITIONS OF Cr IX AND Fe XI IN THE CORONA. Alikaeva, K. V.; Bikchantaeva, Z. M. Astrometriya Astrofiz.; 17: 59-64(1972). (In Russian).

The coronal lines λ 4566 Å Cr IX and 3986 Å Fe XI were investigated. The electron temperature in the corona was found to be 10^6 °K and electron density $\sim 0.8 \cdot 10^3$ cm^{-3}. The calculations were carried out for Cr IX ion populations of levels. (auth)

13516 SPECTROPHOTOMETRY OF PROMINENCES IN THE PHASE PRECEDING DECAY. Rakhubovskii, A. S. Astrometriya Astrofiz.; 17: 64-74(1972). (In Russian).

The results are presented of spectrophotometric processing of prominence spectra in both their quiet and decay phases. A catalog of equivalent widths, central intensities, Doppler half-widths, and half-widths of emission lines was compiled. The reduced Doppler half-widths of D_3 and H, K Ca^+ lines obtained in an active phase of the prominences were considerably larger than those obtained during a quiet phase. Comparison of equivalent widths and central intensities of the hydrogen H_α, H_β, and helium D_3 lines showed that those values increase in the active phase for the D_3 lines and decrease for the H_α, H_β lines. (auth)

13517 PHYSICAL CONDITIONS IN CORONA FROM SPECTRAL OBSERVATIONS OF SOLAR ECLIPSE ON MARCH 7, 1970. Gurtovenko, E. A.; Alikaeva, K. V. Astrometriya Astrofiz.; 15: 55-63(1972). (In Russian).

The emission lines λ5303 Fe XIV, λ4231 Ni XII, λ4567 Cr IX, and λ3987 Fe XI of the solar corona were investigated. The halfwidths and total numbers of particles of line of sight were determined from the line profiles. Emission lines of various classes are considered to arise in the various parts of the corona. Physical conditions in the region of the corona within the heights of $48000 < h < 100000$ km and the position angles $36°E < p < 42°E$ were studied by treating the λ 5303 Å and λ 4231 Å lines. The distribution of n_e and T_e in the corona were found from the excitation and ionization equilibrium. (auth)

13518 SOLNECHNYE PROTSESSY I IKH NABLYUDENIYA. (Solar Processes and Their Observation). Slonim, Yu. M. (ed.). Tashkent; Izdatel'stvo Fan Uzbekskoi SSR (1973). 126p.

Separate abstracts were prepared for 4 of the 7 articles. (WDM)

For abstracts of individual sections see: 13519–13522.

13519 SOLAR FLARES AND PROCESSES IN ACTIVE REGIONS. Slonim, Yu. M. pp 3-56 of Solnechnye Protsessy i Ikh Nablyudeniya. Slonim, Yu. M. (ed.). Tashkent; Izdatel'stvo Fan Uzbekskoi SSR (1973). (In Russian).

On the base of 30-year observations the connection between flares and phenomena on photospheric, chromospheric, and coronal layers of an active region is considered. Spatial localization of the flares is also investigated. The investigations yield the following conclusions; 1) a flare is a natural event in active region evolution; 2) flare activity is determined by initial resources of an active region magnetic energy. It is a function of its poles number and its magnetic field; 3) particularly active flare centers are characterized by two specific features caused by the multipolar groups arising, such as recurrent activity and largescale rotational motions. The motions are of hydrodynamic nature and borrow their energy from the convective zone; 4) flares are divided into two types differing by character of development, physical and dynamic features, localization and time of origin; 5) Evolutional and physical features of a flare depend on its initial height, that is the layer of its origin; 6) a flare develops in optical and radio ranges in the same way. The initial localization and the direction of optical phenomenon spreading coincides with a radioburst; 7) flares are genetically connected with all sporadic and stationary phenomena of the upper layer of an active region. (auth)

13520 PROPER MOTIONS IN MULTICENTRAL GROUPS. Korobova, Z. V.; Tishchenko, V. M.; Tskhai, A. A.; Baturin, V. V. pp 57-76 of Solnechnye Protsessy i Ikh Nablyudeniya. Slonim, Yu. M. (ed.). Tashkent; Izdatel'stvo Fan Uzbekskoi SSR (1973). (In Russian).

Proper motions in 25 multicentral groups (10 bipolar groups, 10 irregular multipolar spots, and 5 complex groups, in the latter a new center of activity joins an old one) were investigated. It is shown that rotational motions prevail in groups of any magnetic class. No correlation between the vortices direction and the hemisphere was found. The intermediate spots rectilinear motion direction is dependent on their magnetic polarity. Spots with p–polarity move westward whereas spots with f–polarity move eastward irrespective of their originating place. In complex groups new unstable spots are seen to change their paths pushing from old, more large and stable spots. The rectilinear and rotational motions velocities were found to be ≈100 m/sec. The rotational motions velocities increase with vortex radius decreasing and vary from 20° to 120° a day. (auth)

13521 CONNECTION BETWEEN SPORADIC CHROMOSPHERIC PROCESSES AND SUNSPOT GROUPS EVOLUTION. Kuleshova, K. F. pp 77-79 of Solnechnye Protsessy i Ikh Nablyudeniya. Slonim, Yu. M. (ed.). Tashkent; Izdatel'stvo Fan Uzbekskoi SSR (1973). (In Russian).

An attempt to divide sporadic chromospheric processes according to the phases of a spot group evolution is undertaken. It is shown that processes with rapid development such as surges are rising on the descending phase of development of an active region and are probably connected with magnetic field decay. On the contrary processes with slow evolution (loop–type prominences) are rising on the ascending phase and are probably connected with penetration of the field into chromosphere and corona. (auth)

13522 MODEL OF THE SOLAR CHROMOSPHERE. Sadikov, A. pp 80-88 of Solnechnye Protsessy i Ikh Nablyudeniya. Slonim, Yu. M. (ed.). Tashkent; Izdatel'stvo Fan Uzbekskoi SSR (1973). (In Russian).

Some modern ideas of the structural and physical properties of the chromosphere are summarized. It is supposed to consist of cold and hot spicules with photospheric and coronal origin correspondingly. The border is 3000 km high. The model based on preceeding results such as the enhancing of Ca, H, He lines Doppler widths with height and the dependence of some physical parameters of chromosphere on the heliographic latitude. (auth)

13523 TRANSVERSE ALFÉN WAVES IN THE SOLAR WIND: ARBITRARY k, v_0, B_0, AND δB. Hollweg, J.V. (High Altitude Observatory, National Center for Atmospheric Research, Boulder, Colorado 80302). J. Geophys. Res. 79: No. 10, 1539-1542 (1 Apr 1974).

Using a simple analysis based on energy conservation, we derive expressions for the spatial variation of the amplitudes of transverse Alfvén waves in the solar wind. We make no assumptions about the solar wind geometry or the directions of propagation, and we do not require that the wave amplitudes be small. (auth)

13524 A TWO-SATELLITE STUDY OF LOW-ENERGY PROTONS OVER THE POLAR CAP DURING THE EVENT OF NOVEMBER 18, 1968. Hynds, R.J. (Physics Department, Imperial College, London, England); Morfill, G.; Rampling, R. J. Geophys. Res. 79: No. 10, 1332-1344 (1 Apr 1974).

A study of low-energy solar proton intensity profiles over the northern polar cap has been made for the November 18 event. Use of data from two satellites crossing the polar cap at closely related universal times has permitted separation of spatial and temporal variations in the intensity profiles early in the event. The resulting profiles have been related to the structure and length of the magnetotail and have been considered in terms of current theories of formation of the magnetotail. (auth)

13525 ON THE ACCESS OF SOLAR PROTONS TO THE SYNCHRONOUS ALTITUDE REGION. Blake, J.B.; Martina, E.F.; Paulikas, G.A. (Aerospace Corporation, Los Angeles, California 90009). J. Geophys. Res. 79: No. 10, 1345-1348 (1 Apr 1974).

Observations of 10- to 90-MeV solar protons were made near the synchronous altitude around the time of a sudden commencement at 0037 UT on August 9, 1972, by using sensors aboard spacecraft 1970-93A and 1972-10A. The observations indicated that the solar protons had direct access to the synchronous altitude region through the dawn flank of the magnetosphere and were transiently trapped with an e-folding lifetime of a few drift periods. A weaker dependence of the cutoff energy upon local time was observed than was predicted by the calculations of Gall et al.(1971). (auth)

13526 SHAPES OF STRONG SHOCK FRONTS IN AN INHOMOGENEOUS SOLAR WIND. Heinemann, M.A.; Siscoe, G.L. (Department of Physics and Center for Space Research, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). J. Geophys. Res. 79: No. 10, 1349-1356 (1 Apr 1974).

The shapes expected for solar-flare-produced strong shock fronts in the solar wind have been calculated, large-scale variations in the ambient medium being taken into account. A linear mathematical model was used, based on the assumptions that (1) the pressure immediately behind a shock front is constant over the surface of the front, (2) the variations in the ambient medium are time stationary in a frame of reference corotating with the sun, and (3) the effects of the interplanetary magnetic field can be neglected. The shock fronts were assumed to be spherically symmetric near the sun. It has been shown that for reasonable ambient solar wind conditions the mean and the standard deviation of the east-west shock normal angle are in agreement with experimental observations including shocks of all strengths. The results further suggest that near a high-speed stream it is difficult to distinguish between corotating shocks and flare-associated shocks on the basis of the shock normal alone. Although the calculated shapes are outside the range of validity of the linear approximation, these results indicate that the variations in the ambient solar wind may account for large deviations of shock normals from the radial direction. (auth)

13527 SOME EFFECTS OF DIFFUSION ON THE FLOW OF IONS IN THE SOLAR WIND. Nakada, M.P. (NASA Goddard Space Flight Center, Greenbelt, Maryland 20771). J. Geophys. Res. 79: No. 10, 1364-1367 (1 Apr 1974).

The contribution of diffusive effects to the near equality of flow velocities of H^+ and heavier ions of the solar wind at 1 AU is examined. Frictional drag on heavy ions from average solar wind fluxes of H^+ appears to make an appreciable contribution to equalizing velocities. The frictional drag on H^+ due to the presence of heavy ions may make an appreciable contribution to equalizing flow velocities, since compensating increases in coronal temperatures may be required in order to give solar wind velocities for H^+. However, rather large enhancements of heavy ions near the sun appear to be required. If appreciable enhancements of heavy ions extend beyond about 2.5 solar radii, significant increases in heavy ion temperatures above H^+ temperatures may be produced. This temperature difference may contribute to equalizing flow velocities and may contribute to the explanation of measured temperature differences at 1 AU between H^+ and He^{++}. (auth)

13528 ALFVÉNIC ACCELERATION OF SOLAR WIND HELIUM AND RELATED PHENOMENA 1. THEORY. Hollweg, J.V. (High Altitude Observatory, National Center for Atmospheric Research Boulder, Colorado 80302). J. Geophys. Res. 79: No. 10, 1357-1363 (1 Apr 1974).

We present a new physical mechanism by which helium nuclei can be preferentially accelerated by Alfvén waves in the solar wind. The mechanism works as follows. The acceleration of the solar wind by Alfvén wave pressure is basically a $\delta J \times \delta B$ force; but the wave-associated current δJ carried by a given plasma species depends, via the Lorentz transformation, on the bulk velocity of that species, and thus species that move at different bulk velocities experience different accelerations. In the solar wind this differential acceleration can for the most part be interpreted as an additional frictional interaction between protons and helium nuclei. Numerical estimates indicate that this interaction is important at 1 AU. It is expected that this additional friction will be able to account for the observed fact that helium nuclei almost never flow slower than protons in the solar wind; detailed numerical calculations are deferred to a later paper, however. Although our calculation is done for Alfvén waves, we argue that the basic physics of our mechanism is applicable to a wide variety of waves, and we suggest that it may be important for cosmic rays, interstellar gas, comet tails, and the earth's (and Jupiter's) geomagnetic tail. (auth)

13529 SOLAR CORONAL LINE PROFILES IN THE EXTREME-ULTRAVIOLET. Feldman, U. (E. O. Hulbert Center for Space Research, Naval Research Laboratory, Washington, D.C. 20375); Behring, W.E. Astrophys. J. Lett. 189: No. 1, L45-L46 (1 Apr 1974).

We report here the first direct measurements of the widths of the lines emitted by the solar corona from 170 to 370 Å. The transitions 1s-2p and 1s-4p in He II are wider than 0.1 Å, perhaps showing the effect of optical depth. The lines of highly ionized O, Mg, Si, S, and Fe have widths which may be ascribed to a mean random turbulent velocity of about 30 km s^{-1} in addition to thermal Doppler broadening. (auth)

13530 SOLAR X-RAY BRIGHT POINTS. L.Golub; Krieger, A.S.; Silk, J.K.; Timothy, A.F.; Vaiana, G.S. (American Science and Engineering, Cambridge, Massachusetts). Astrophys. J. Lett. 189: No. 2, L93-L97 (15 Apr 1974).

Preliminary analysis of photographs from the S-054 X-ray telescope aboard Skylab has shown that bright points have a statistical distribution of lifetimes with a mean of eight hours. The lifetime of a bright point is approximately proportional to its maximuum area, which is typically 2×10^9 km^2. A small bright core generally develops during the middle part of the bright-point lifetime with area $\sim10^7$ km^2. A small fraction of bright points are seen to increase their surface brightness by several orders of magnitude on a time scale of minutes. These "flares" occur at all latitudes from the equator to the poles. The first order, bright points are uniformly distributed across the solar surface. An estimated 1500 X-ray bright points emerge per day, possibly bringing more new magnetic flux to the surface than is contributed by the major active regions. (auth)

13531 THE OBLATENESS OF THE SUN. Dicke, R.H.; Goldenberg, H.M. (Joseph Henry Laboratories, Physics Department, Princeton University, Princeton, N.J. 08540). Astrophys. J. Suppl. Ser. 27: No. 241, 131-182 (Mar 1974).

The solar oblateness observations of 1966 are analyzed. Included are measures of the vertical and diagonal components of the oblateness observations of 1966 are analyzed. Included are measures of the vertical and diagonal components of the oblateness. These components represent the fractional contractions of the solar disk along the north-south and the northeast-southwest diameters, respectively. Also included are the annular-ring measures of the equatorial brightening of the solar disk. These "brightness data" are obtained by scanning a thin annular aperture centered on the solar disk. The daily values of the diagonal component of the oblateness are correlated with the observatory temperature and humidity and with atmospheric transparency to test for a correlated atmospheric bias of the results. Seasonal averages of the hourly averages of the data provide measures of (and corrections for) the seeing distortions of the solar image. The correction of the diagonal component for seeing effects is zero. Functions derived from distributions about the limb of faculae, sunspots, magnetic fields, and prominences are correlated with the diagonal component of the oblateness. Only the facular signal is important. The facular contribution is greatest when the largest amount of photosphere is exposed at the limb. After subtracting the facular contribution to the signal, the residual oblateness is independent of the amount of photosphere exposed. Averaged over all three limb exposures, only 14 percent of the oblateness signal is due to faculae. Correlation coefficients of the facular signal with the "brightness data" show no equatorial brightening over and above that due to faculae. The $25^d.67$ periodicity of the solar oblateness is studied. The periodic autocorrelation function of the oblateness fluctuation, the periodic fluctuation component are evaluated. The periodic fluctuation component exhibits sharp positive peaks separated by 12 days. The values for the oblateness obtained from the diagonal and vertical components are consistent with each other and yield a mean value of $\Delta r/r = 4.51 \pm 0.34 \times 10^{-5}$. The solar quadrupole moment consistent with this value, $J = 2.47 \pm 0.23 \times 10^{-5}$, implies a correction of $2''.98 \pm 0''.27$ per century to the classical excess motion of Mercury's perihelion. (auth)

13532 RESISTIVE DIFFUSION OF FORCE-FREE MAGNETIC FIELDS IN A PASSIVE MEDIUM. III. ACCELERATION OF FLARE PARTICLES. Low, B.C. (Enrico Fermi Institute, University of Chicago). Astrophys. J. 189: No. 2, 353-358 (15 Apr 1974).

We have previously suggested that solar flares are triggered by the resistive diffusion of force-free magnetic fields in a passive medium. We consider a one-dimensional model in which an increasingly large electric field is induced by a rapidly evolving magnetic field. We estimate, in the case of solar flares, the energies to which protons and electrons may be directly accelerated by such an induced electric field. (auth)

13533 DIRECT OBSERVATIONAL EVIDENCE FOR THE PROPAGATION AND DISSIPATION OF ENERGY IN THE CHROMOSPHERE. Liu, S. (High Altitude Observatory, National Center for Atmospheric Research, Boulder, Colorado). Astrophys. J. 189: No. 2, 359-365 (15 Apr 1974).

In studying a time sequence of the Ca II K-line spectrograms of high spatial and time resolutions taken in a quiet region at the center of the disk, we find intensity perturbations that propagate from the far wing toward the line core. That is, there is a time lag between the intensity perturbation maxima at K_2 and in the K_1 wing. This perturbation is interpreted as a local heating in the chromosphere due to an upward propagating disturbance generated in the lower layers. This phenomenon tends to repeat with a period of about 180 s, and is observed over 90 percent of the region covered by the slit. We have estimated the mechanical flux and the excess radiative flux of one prominent feature for discussion purposes. We conclude that the mechanical flux based on the acoustic-wave assumption is probably not enough to balance the excess radiative loss. (auth)

13534 DEUTERIUM AND TRITIUM FROM SOLAR FLARES AT ~10 MeV PER NUCLEON. Anglin, J.D.; Dietrich, W.F.; Simpson, J.A. (Enrico Fermi Institute, University of Chicago). Astrophys. J. Lett. 186: No. 1, L41-L46 (15 Nov 1973).

High-resolution, solid-state charged-particle telescopes on the Earth satellites IMP-5 and IMP-6 have made it possible to resolve all the hydrogen and helium isotopes of solar-flare origin in groups of solar flares within the period 1969 September-1972 November. The average isotopic ratios, Γ, in equal energy per nucleon intervals are: Γ ($^2H/^1H$) $=8\pm2) \times10^{-5}$; Γ ($^2H/^1H$) $= (2.1\pm1.0) \times10^{-5}$; and Γ ($^2H/^4He$) $=1.1\pm0.2) \times10^{-3}$, which can be compared with our previous result with Γ ($^3He/^4He$) $= 2 \times 10^{-2}$. We conclude that the high yields of ^2H, ^3H (with a half-life of ~12 years and, hence, of recent origin), and ^3He can only be explained by high-energy nuclear interactions and that the acceleration process takes place in the chromosphere. (auth)

13535 DETECTION OF OH AT 18-CENTIMETER WAVELENGTH IN COMET KOHOUTEK (1973f). Turner, B.E. (National Radio Astronomy Observatory, Charlottesville, Virginia). Astrophys. J. Lett. 189: No. 3, L137-L139 (1 May 1974).

The 1665- and 1667-MHz lines of OH have been observed in absorption toward comet Kohoutek and are apparently optically thin. It is argued that the OH absorption arises in an extended halo about the comet, and that the OH is being pumped by solar ultraviolet radiation. (auth)

13536 A CORRELATIVE STUDY OF SSC'S, INTERPLANETARY SHOCKS, AND SOLAR ACTIVITY. Chao, J.K. (Lunar and Planetary Laboratory, University of Arizona, Tucson, Arizona 85721); Lepping, R.P. J. Geophys. Res. 79: No. 13, 1799-1807 (1 May 1974).

We have examined 93 ssc's during the 4-year period from 1968 to 1971 at and near the peak of the solar activity cycle. Of the 93 ssc's 81 could be associated with solar activity such as solar flares and type 2 and type 4 radio bursts. The mean propagation speeds of these flare-associated events ranged from 400 to 1000 km/s, the average speed being 600-700 km/s. Disturbances associated with 48 of the ssc's have been studied in detail by using the corresponding interplanetary (IP) magnetic field and plasma data when they were available. We found that 41 of the 48 disturbances corresponded to IP shock waves, and the remaining 7 events were tangential discontinuities. Thirty percent of the IP shocks had thick structure (i.e., the magnetic field jump across the shock occurred over a distance much greater than 50 proton Larmor radii). Also given is a statistical study of the gross geometry of a 'typical' or average shock surface based on multiple spacecraft sightings and their relative orientation with respect to the solar flare and/or solar activity. By considering the orientations of 22 well-determined shock normals in relation to the positions of the parent flares on the solar disk, a method that is a modification of one given by Taylor (1969), it is suggested that a typical shock front propagating out from the sun at 1 AU has a radius of curvature of the order of 1 AU. Also given are some general properties of oblique IP flare shocks. (auth)

13537 ACCELERATION OF THE SOLAR WIND BY THE INTERPLANETARY MAGNETIC FIELD. Barnes, A. (Max-Planck-Institut für Physik and Astrophysik, Institut für Extraterrestrische Physik, Garching b. München, Germany). Astrophys. J. 188: No. 3, 645-648 (15 Mar 1974).

The effect of the azimuthally symmetric (spiral-model) interplanetary magnetic field on radial solar-wind flow is reexamined. It is found that when the azimuthal motion of the plasma due to this field is considered, there is no significant radial acceleration of the plasma by the magnetic field. This result contradicts a recent calculation by Whang, who found a 17 percent increase in solar-wind velocity due to acceleration by the spiral-model magnetic field. This acceleration is an artifact of his model, caused by the neglect of azimuthal motion of the plasma, and is diminished by a factor ~10 when azimuthal motions are included. (auth)

13538 HELIUM EXCITATION IN THE SOLAR CHROMOSPHERE: He I IN A HOMOGENEOUS CHROMOSPHERE. Milkey, R.W. (Kitt Peak National Observatory); Heasley, J.N.; Beebe, H.A. Astrophys. J. 186: No. 3, 1043-1052 (15 Dec 1973).

We report kinetic equilibrium calculations for an He I atom with 13 bound levels in a homogeneous model chromosphere. We evaluate the effectiveness of coronal radiation in producing ionization of chromospheric helium and the methods of populating the excited levels from which the visible and infrared transitions arise. The homogeneous model gives a reasonable representation of quiet-Sun, disk-center conditions, but fails to reproduce the eclipse data. (auth)

13539 A PHOTOSPHERIC SOLAR IRON ABUNDANCE INDEPENDENT OF LINE-SHAPE PARAMETERS. Huber, M.C.E.; Tubbs, E.F. (Center for Astrophysics, Harvard College Observatory). Astrophys. J. 186: No. 3, 1053-1058 (15 Dec 1973).

The solar iron abundance has been determined from the 5127.68 Å resonance line of Fe I. This line has an equivalent width small enough to make the derived abundance nearly independent of assumptions on line-shape parameters. Blending of the line by molecular lines has been allowed for, and the sensitivity of the resulting abundance to the choice of a particular atmosphere (including non-LTE) was assessed. The abundance, $\log (N_{Fe}/N_H) + 12 = 7.64 (+0.18/-0.20)$, is in good agreement with that derived from three stronger resonance lines, provided that a microturbulent parameter of 0.5 km s^{-1} is assumed and the damping is estimated to have 20 to 30 times the classical value. (auth)

13540 SUNSPOTS, SUPERGRANULES, AND THE DEPTH OF THE SOLAR CONVECTION ZONE. Mullan, D.J. (Bartol Research Foundation of The Franklin Institute, Swarthmore, Pennsylvania). Astrophys. J. 186: No. 3, 1059-1063 (15 Dec 1973).

It is suggested that a large sunspot group can be regarded as a special kind of convection cell penetrating the entire depth of the solar convection zone (analogous to a supergranule, according to the author's model). Theoretical results of Vickers are used to show that the diameters of supergranules and large sunspots should lie in the range 18,000-65,000 km. This agrees well with results of Bumba et al., who found preferred spot sizes in large groups ranging from 18,000 to 54,000 km. Spots with diameters less than 18,000 km are probably shallower than the convection zone, i.e., they have depths less than 10,000 km. Implications for flare stars are noted. (auth)

13541 CONVECTIVE INSTABILITY OF A RAPIDLY ROTATING COMPRESSIBLE FLUID. Heard, W.B. (Kitt Peak National Observatory, Tucson, Arizona). Astrophys. J. 186: No. 3, 1065-1081 (15 Dec 1973).

The convective instability of a rotating, polytropic layer of gas is studied for the cases of constant kinematic viscosity and constant dynamic viscosity. Asymptotic solutions of the linear, stability equations in the limit of rapid rotation are obtained with the application of singular perturbation theory. Solutions of the lowest-order interior equations are obtained for a thin layer as a perturbation of the Rayleigh-Boussinesq equations, in closed form for special values of the polytropic index, and by numerical methods for the generic case. Global convective instability can occur even though some portions of the fluid are locally stable, and it is enhanced if the level of greatest local instability is located at the top of the layer. A region in which velocity amplitudes are very small can develop at either boundary of very thick layers. The preferred mode is damped in the upper portions of the layer, more severely with constant dynamic viscosity than with constant kinematic viscosity. Ekman boundary layers are formed at the top and bottom boundaries. The theory provides an idealized model of the giant cells on the Sun. The effect of rotation is to decrease the horizontal scale of the cells. A horizontal scale of the order of 10^5 km is predicted. (auth)

13542 WAVES IN THE SOLAR ATMOSPHERE. III. THE PROPAGATION OF PERIODIC WAVE TRAINS IN A GRAVITATIONAL ATMOSPHERE. Stein, R.F. (Department of Physics, Brandeis University, Waltham, Massachusetts); Schwartz, R.A. Astrophys. J. 186: No. 3, 1083-1089 (15 Dec 1973).

The validity of weak shock theory for the propagation of waves in a gravitational atmosphere is examined by comparing its results with those from numerical integration of the exact equations of motion. The weak-shock approximation is not valid for periods longer than half the acoustic cutoff. In addition, the relation between the 300-s solar oscillation and chromospheric and coronal heating is described. (auth)

13543 INTERPLANETARY LYMAN-BETA EMISSIONS. Paresce, F. (Spaces Sciences Laboratory, University of California, Berkeley). Astrophys. J. 186: No. 3, 1091-1096 (15 Dec 1973).

The intensity of the diffuse hydrogen Lβ glow at 1025 Å due to resonance scattering of the solar H I 1025 Å line by interstellar and interplanetary hydrogen is derived. Two sources of neutral hydrogen are considered: the local interstellar medium interacting with the solar system, and the dust de-ionization of the H^+ component solar wind. The calculated intensities vary from ~0.1 to ~5 rayleighs. It is shown that if the dust geometrical factor is less than or equal to 5×10^{-18} cm^{-1}, observations of backscattered Lβ radiation will provide a unique determination of the density and temperature of the local interstellar medium. (auth)

13544 THEORY OF SOLAR FLARES. Vil'koviskii, E.Y. (Astrophysical Institute, Academy of Sciences of the Kazakh SSR). Sov. Astron.-AJ 17: No. 5, 640-642 (Mar 1974).

Thermal balance and the kinetic properties of charged particles in a flare filament with an electric field are studied. It is shown that it is necessary to consider the change in the structure of the exterior magnetic field to ensure low inductance. (auth)

13545 COMPLEX DYNAMIC SPECTRA OF WIDE-BAND SOLAR RADIO BURSTS. Vedeneev, Y.B. (Gor'kii Radiophysics Institute). Sov. Astron.-AJ 17: No. 5, 691-692 (Mar 1974).

Dynamic spectra are described for complex events observed on January 14, 1971, at 100-250 and 500-1000 MHz, including the decimeter continuum, fast-drift decimeter bursts, and type I and III bursts, accompanied by microwave bursts during a flare of importance $\geq$1 n. The first maximum in the decimeter continuum and the strongest type III burst occurred simultaneously, preceding the maximum of the microwave burst by 1.2 min. (auth)

Galaxies

Refer also to abstract 13451.

13546 A DISTANCE LIMIT FOR NGC 7318B IN STEPHAN'S QUINTET. Shostak, G.S. (National Radio Astronomy Observatory, Charlottesville, Virginia). Astrophys. J. Lett. 189: No. 1, L1-L3 (1 Apr 1974).

Observations at 21 cm of NGC 7318B in Stephan's Quintet show that H I flux from this galaxy is no more than 0.008 f.u. The resulting limit on M_{HI} is incompatible with a distance as small as 15 Mpc, which is the accepted distance of the low-redshift member of the Quintet, NGC 7320. (auth)

13547 DISCOVERY AND CO OBSERVATIONS OF A NEW MOLECULAR SOURCE NEAR M17. Lada, C.; Dickinson, D.F.; Penfield, H. (Center for Astrophysics, Harvard College Observatory). Astrophys. J. Lett. 189: No. 1, L35-L37 (1 Apr 1974).

A rich new source of molecular line radiation has been found near M17. Its position is in the immediate vicinity of the new infrared source recently discovered by Kleinmann and Wright and very near the position of a strong time-varying H_2O maser. Extended emission from HCN, SO, and millimeter H_2CO has been detected. Emission lines of ^{12}CO and $^{13}C^{16}O$ have been mapped throughout this region, and $^{12}C^{18}O$ has been detected in two locations. Results of the CO observations set a lower limit on the mass of this source of $M > 6000\ M_\odot$ and indicate that the cloud may be undergoing collapse. (auth)

13548 $^{12}C/^{13}C$ ABUNDANCE RATIOS FROM OBSERVATIONS OF INTERSTELLAR $H_2{}^{13}C^{16}O$. Zuckerman, B. (University of Maryland and University of California, Berkeley); Buhl, D.; Palmer, P.; Snyder, L.E. Astrophys. J. 189: No. 2, 217-220 (15 Apr 1974).

A study of the interstellar $H_2{}^{12}C^{16}O/H_2{}^{13}C{}^{16}O$ abundance ratio in the direction of seven H II regions suggests that the galactic $^{12}C/^{13}C$ ratio is approximately terrestrial except, possibly, in massive clouds near the galactic center. If a systematic difference does exist between the typical interstellar $H_2{}^{12}C^{16}O/H_2{}^{13}C^{16}O$ ratio and the terrestrial $^{12}C/^{13}C$ ratio, it appears that the latter ratio is the larger. An unsuccessful search for the $1_{11}-1_{10}$ transition of $H_2{}^{12}C^{17}O$ in Sgr B2 yielded an $H_2{}^{12}C^{17}O/H_2{}^{13}C^{16}O$ abundance $\leq$1/7. (auth)

13549 MOLECULAR CH, CH^+, AND H_2 IN THE INTERSTELLAR GAS. Watson, W.D. (Departments of Astronomy and Physics, University of Illinois, Urbana). Astrophys. J. 189: No. 2, 221-225 (15 Apr 1974).

Reactions of molecular H_2 with CH^+ and CH_2^+ are likely to lead to the formation of interstellar CH at a rate that is consistent with observation. Rapid destruction of CH^+ by the reaction $CH^+ + H_2 \rightarrow CH_2^+ + H$ indicates that CH^+ and H_2 observed in the same direction occur at different locations. CH is expected to occur with the H_2. (auth)

13550 RECOMBINATION LINES FROM H I GAS TOWARD ORION A. Chaisson, E.J. (Center for Astrophysics, Harvard College Observatory and Smithsonian Astrophysical Observatory); Lada, C.J. Astrophys. J. 189: No. 2, 227-237 (15 Apr 1974).

Long-integration, high spectral-resolution observations of the 158α and 166α recombination-line spectra are reported toward Ori A. Recombination lines of ^1H, of ^{12}C, and possibly of a superposition of heavier atoms (principally ^{24}Mg, ^{28}Si, ^{32}S, and ^{56}Fe) are observed to originate in a predominantly neutral region that exists somewhere along the line of sight to the nebula. Assuming normal cosmic abundance of carbon and uniform mixing of the C^+ and H^+ ions in the H I gas, we derive $\langle T_{gas}\rangle = 400^\circ$ $(+900^\circ, -600^\circ)$ K, $\langle n(H^+)/N\rangle \simeq 5\times10^{-4}$, and $\langle n(e)/N\rangle \simeq 10^{-3}$, where $N = n(H) + 2n(H_2)$; these values are considerably uncertain. If our heavy-element interpretation is correct, then we find an abundance ratio [Mg+Si+S+Fe]/[C] that agrees reasonably well with accepted cosmic abundance. The fractional ionization of hydrogen and the relative electron density can be considerably reduced if carbon is depleted, or if the H I region is dense ($NL > 3\times10^{21}$ cm^{-2}) and ionized by cosmic rays. However, if the hydrogen in the cool region is ionized by X-rays, these quantities are probably lower limits. (auth)

13551 THE SOUTHERN SEYFERT GALAXIES NGC 1566 AND NGC 3783. Osmer, P.S.; Smith, M.G. (Cerro Tololo Inter-American Observatory, La Serena, Chile); Weedman, D.W. Astrophys. J. 189: No. 2, 187-194 (15 Apr 1974).

High-resolution spectrophotometry, photometry, and photographs are presented for the bright southern hemisphere Seyfert galaxies NGC 1566 and NGC 3783. NGC 1566 is found to have a very faint emission-line luminosity for a Seyfert, the absolute Hα luminosity being 11×10^{39} ergs s^{-1}; the Balmer-line profiles are as broad as those in much brighter objects but are peculiar because the Hα and Hβ profiles appear to be different. NGC 3783 is a well-defined barred spiral with nearly circular spiral arms and has a nucleus resembling in all respects the bright Seyfert galaxies except that the Balmer-line wings are asymmetrical. (auth)

13552 THE ABSORPTION-LINE SPECTRUM OF NGC 4151. Anderson, K.S. (Kitt Peak National Observatory). Astrophys. J. 189: No. 2, 195-203 (15 Apr 1974).

Spectroscopic observations of the blueshifted absorption-line spectrum of NGC 4151 are presented. The strengths and profiles of these lines are variable and the variations in strength are correlated with the ultraviolet brightness fluctuations of the nuclear continuum. The lines arise from metastable levels of H I and He I and the level populations seem to be governed, via photoionization, by the brightness of the variable continuum source. On the basis of the available observational information, it is concluded that the region in which these absorption features arise is characterized by $n_e > 10^6$ cm^{-3} and is located ~0.025 pc from the continuum source. The variations in absorption-line strength are approximately sufficient to account for the observed emission-line variability near Hα. It is also shown that the broad Balmer emission wings must arise in a region interior to that in which the absorption lines are formed. The wing-emission region has $n_e > 10^7$ cm^{-3} and is optically thick to electron scattering. (auth)

13553 THE INTERSTELLAR DEPLETION MYSTERY, OR WHERE HAVE ALL THOSE ATOMS GONE. Greenberg, J.M. (State University of New York at Albany, and Dudley Observatory). Astrophys. J. Lett. 189: No. 2, L81-L85 (15 Apr 1974).

The observed depletion of intermediate-weight elements O, C, and N from the interstellar medium is shown to be significantly greater than can be accounted for by accretion on interstellar dust. A number of possible explanations are presented, ranging from the existence in interstellar space of many "snowballs" intermediate in size between dust grains and comets to the existence of many far more complicated interstellar molecules than have been detected. (auth)

13554 DUST AND GAS IN THE ORION MOLECULAR CLOUD: OBSERVATIONS OF 1-MILLIMETER CONTINUUM AND 2-CENTIMETER H_2CO EMISSION. Harvey, P.M.; Gatley, I. (California Institute of Technology); Werner, M.W.; Elias, J.H.; Evans II, N.J.; Zuckerman, B.; Morris, G.; Sato, T.; Litvak, M.M. Astrophys. J. Lett. 189: No. 2, L87-L91 (15 Apr 1974).

The Orion Nebula region has been mapped over a $3'\times6'$ region in the continuum at 1 mm and in the $2_{11}-2_{12}$ transition of H_2CO at 2 cm. The similarity of the two maps is strong evidence that the 1-mm radiation originates in the molecular cloud. The column density of hydrogen molecules through the cloud, derived from the H_2CO results, is $\sim2\times10^{23}$ cm^{-2}; dust associated with this amount of gas would produce sufficient thermal emission to account for the observed 1-mm continuum radiation. The mass of the region observed is estimated to be $\sim500\ M_\odot$. The radial velocities and linewidths of the H_2CO emission are discussed with respect to collapse, rotation, and turbulence. (auth)

13555 GALACTIC ARM STRUCTURE AND GAMMA-RAY ASTRONOMY. Bignami, G.F.; Fichtel, C.E. (NASA/Goddard Space Flight Center, Greenbelt, Maryland). Astrophys. J. Lett. 189: No. 2, L65-L67 (15 Apr 1974).

In an attempt to explain the observed unexpectedly high-energy gamma-radiation over a broad region of the galactic plane in the general direction of the galactic center, a model is proposed wherein the galactic cosmic rays are preferentially located in the high-matter-density regions of galactic arm segments, as a result of the weight of the

matter in these arms tying the magnetic fields and hence the cosmic rays to these regions. The presently observed longitudinal distribution of galactic γ-rays can be explained with the current estimate of the average galactic matter density, if the average ratio of arm to interarm matter is 5:1 for the major arm segments toward the galactic center from the Sun, and if the cosmic-ray density normalized to its local value is assumed to be directly proportional to the matter density. (auth)

13556 ON IONIZATION IN THE H I REGIONS. Hobbs, L.M. (Yerkes Observatory, University of Chicago). Astrophys. J. Lett. 188: No. 3, L107-L109 (15 Mar 1974).

A comparison is made of the K I, Na I, Ca II, and H I interstellar absorption lines formed in relatively low-density interstellar clouds in H I regions. The data indicate that the fractional ionization n_e/n_H is nearly constant for a range in densities n_H covering a factor of 15. If ionization balance exists in the clouds, then ionization of hydrogen by either low-energy cosmic rays or soft X-rays cannot be the principal source of the observed free electrons, and the hydrogen ionization rate ζ is less than 10^{-16} s^{-1} for these processes. (auth)

13557 IFRARED POLARIZATION OF THE GALACTIC NUCLEUS. Dyck, H.M. (Institute for Astronomy, University of Hawaii); Capps, R.W.; Beichman, C.A. Astrophys. J. Lett. 188: No. 3, L103-L104 (15 Mar 1974).

We have detected 2.4±0.4 percent linear polarization at 11 μ in the direction of the galactic center. The electric vector lies approximately perpendicular to the plane of the Galaxy. (auth)

13558 ROTATIONAL EXCITATION OF INTERSTELLAR H_2. Spitzer, L., Jr.; Cochran, W.D. (Princeton University Observatory). Astrophys. J. Lett. 186: No. 1, L23-L28 (15 Nov 1973).

Detailed measures of N(J), the column density of H_2 molecules in rotational level J, show that for $N(0) > 10^{17}$ cm^{-2}, N(J) drops steeply as J increases up to 2 or 3, presumably because of collisions with the gas; the mean gas temperature, determined from N(1)/N(0), is 81°, in agreement with 21-cm results. For J > 2 or 3 the decrease of N(J) is less rapid, corresponding to an excitation temperature, T_{ex}, between 180° and 390° in different stars with this high N(0). For $N(0) < 10^{15}$ cm^{-2}, a constant T_{ex} generally describes the distribution of N(J) over all observed J (up to 3 or 4) in each star, with T_{ex} between 315° and 1110°. Some of this excitation is apprently due to newly formed molecules which leave the grains with considerable internal energy and about 3 eV of translational kinetic energy, producing the relatively wide lines observed in some stars at high J. At low J the mean radiative life is much increased, and the newly formed molecules slow down by collisions before absorbing a Lyman photon. (auth)

13559 HOT H_2 AND INTERSTELLAR SHOCKS. Aannestad, P.A. (Institute for Space Studies, Goddard Space Flight Center); Field, G.B. Astrophys. J. Lett. 186: No. 1, L29-L32 (15 Nov 1973).

The rotational excitation of H_2 molecules by interstellar shock waves is calculated. Level populations integrated through a shock in a cloud of density of 10 cm^{-3} have nearly exponential distributions, with effective rotational temperatures $T_r = 15V^{1.9}$°K, where V is the shock velocity in km s^{-1}. Ortho-para conversion is effective for high shock velocities, but not for low ones, so that the degree of alternation of intensities of rotational lines in the Lyman absorption band should be correlated with V, and therefore with T_r. The results are compared with observations of H_2 rotational levels made by the Copernicus satellite. (auth)

13560 OBSERVATIONAL EVIDENCE THAT THE COMA CLUSTER IS NOT BOUND BY IONIZED INTRACLUSTER GAS. Davidsen, A.; Bowyer, S. (Astronomy Department and Space Sciences Laboratory, University of California, Berkeley); Welch, W. Astrophys. J. Lett. 186: No. 3, L119-L122 (15 Dec 1973).

We have obtained an upper limit on the brightness temperature of the core of the Coma cluster at 23 GHz, including a correction for Compton scattering of the microwave background by hot gas in the cluster. Our new radio data, in combination with a reinterpretation of our far-ultraviolet data and an analysis of recent soft X-ray results, allows us to conclude on purely observational grounds that the Coma cluster is not bound by ionized gas. (auth)

13561 SAS-2 OBSERVATIONS OF GAMMA RAYS FROM THE GALACTIC PLANE. Kniffen, D.A.; Hartman, R.C.; Thompson, D.J.; Fichtel, C.E. (Goddard Space Flight Center, Greenbelt, Maryland). Astrophys. J. Lett. 186: No. 3, L105-L110 (15 Dec 1973).

The SAS-2 γ-ray experiment has made measurements on the high-energy (>30 MeV) γ-rays coming from the galactic-center region. The γ-radiation in this region is very much more intense than in the anticenter region, in agreement with the observations made with the OSO-3 experiment of Kraushaar et al., and exhibits a narrow distribution (the 2 σ width is no more than 6°) along the plane which is nearly uniform in intensity from 330° to 30°. The average value, including present uncertainties other than statistical is (1.15 [+0.40, −0.35]) $\times 10^{-4}$ photons (cm^2 radian $s)^{-1}$. The energy spectrum in the range from 35 to 210 MeV is quite flat, consistent with a π^0-decay spectrum due to interactions between cosmic rays and interstellar matter, or a mixture of this spectrum and a spectrum formed by Compton radiation from cosmic-ray electrons. The intensity of the radiation in the anticenter direction is consistent with that expected if the origin is interactions between cosmic rays and interstellar matter, namely, 0.2×10^{-4} photons (cm^2 radian $s)^{-1}$. (auth)

13562 INTERSTELLAR DEUTERIUM ABUNDANCE IN THE DIRECTION OF BETA CENTAURI. Rogerson, J.B., Jr.; York, D.G. (Princeton University Observatory). Astrophys. J. Lett. 186: No. 3, L95-L98 (15 Dec 1973).

Interstellar absorption lines due to the Lyman series transitions in hydrogen and deuterium have been observed in the spectrum of β Cen. From these, a ratio of deuterium to hydrogen, by number, of 1.4±0.2 (m.e.) $\times 10^{-5}$ has been obtained. If one assumes that the present deuterium abundance is a relic of the big-bang element synthesis, a value of 1.5×10^{-31} g cm^{-3} for the present density of the Universe is derived. (auth)

13563 LABORATORY MICROWAVE SPECTRUM OF ETHYLENE OXIDE. Hirose, C. (Laboratory of Molecular Spectroscopy, Tokyo Institute of Technology, O-okayama, Meguro-ku, Tokyo 152, Japan). Astrophys. J. Lett. 189: No. 3, L145-L146 (1 May 1974).

Observed laboratory frequencies for H_2COCH_2 and the rotational and centrifugal distortion constants derived therefrom are listed. (auth)

13564 A NEW SOURCE OF INTENSE MOLECULAR EMISSION IN THE RHO OPHIUCHI COMPLEX. Encrenaz, P.J. (Goddard Institute for Space Studies, New York City). Astrophys. J. Lett. 189: No. 3, L135-L136 (1 May 1974).

A new source of intense molecular line emission has been found in a dark cloud in the ρ Ophiuchi complex. The densities implied by the observations are higher than 10^3 cm^{-3}. (auth)

13565 LARGE-SCALE EFFECTS OF SUPERNOVA REMNANTS ON THE GALAXY: GENERATION AND MAINTENANCE OF A HOT NETWORK OF TUNNELS. Cox, D.P.; Smith, B.W. (Space Physics Laboratory, Department of Physics, University of Wisconsin, Madison, Wisconsin 53706). Astrophys. J. Lett. 189: No. 3, L105-L108 (1 May 1974).

It is found that a supernova rate on the order of 1 per 50 years in the gaseous disk of our Galaxy is sufficient to generate and maintain throughout the interstellar medium a mesh of interconnected tunnels containing very low-density gas. This tunnel system would have $n \lesssim 10^{-2}$ cm^{-3}, T $10^{6.0}$ K, very low magnetic field strength, tunnel radii ~10 pc, and would occupy roughly half the interstellar volume. Such a tunnel network may already have been observed in soft X-ray emission, in ultraviolet absorption of O VI against background stars, in the seemingly chaotic distribution of local H I, and in the stringy appearance of velocity-correlated large-sacle H I features. (auth)

13566 A NEW LIMIT ON THE INTERSTELLAR ABUNDANCE OF BORON. Morton, D.C. (Princeton University Observatory); Smith, A.M.; Stecher, T.P. Astrophys. J. Lett. 189: No. 3, L109-L111 (1 May 1974).

We report a new upper limit on interstellar boron in the direction of ζ Oph, obtained by making 25 scans across the B II resonance line at 1362.461 Å with the Copernicus satellite. We find $B/H \leq 7.6 \times 10^{-11}$ by number, implying that boron in the interstellar gas is depleted by a factor of about 60 relative to boron in carbonaceous chondrites. These results are related to theories of the formation of grains, and the flux of cosmic rays. (auth)

13567 THE CORRELATION OF RADIO EMISSION AND OPTICAL TYPE WITH X-RAY EMISSION FROM CLUSTERS OF GALAXIES. Owen, F.N. (University of Texas Radio Astronomy Observatory, Department of Astronomy, University of Texas at Austin, Austin, Texas). Astrophys. J. Lett. 189: No. 2, L55-L58 (15 Apr 1974).

A correlation of X-ray emission from clusters of galaxies with radio emission and with Rood and Sastry optical cluster type is reported. Of the 10 clusters with the highest known absolute X-ray luminosity, at least nine are strong radio sources. Also, eight of these 10 clusters are characterized by Rood and Sastry as containing one or two outstanding dominant galaxies. In light of these correlations the two most likely X-ray emission mechanisms—inverse Compton scattering and thermal bremsstrahlung—are discussed. (auth)

13568 COPERNICUS X-RAY OBSERVATIONS OF NGC 1275 AND THE CORE OF THE PERSEUS CLUSTER. Fabian, A.C.; Zarnecki, J.C.; Culhane, J.L.; Hawkins, F.J. (Mullard Space Science Laboratory, University College London); Peacock, A.; Pounds, K.A.; Parkinson, J.H. Astrophys. J. Lett. 189: No. 2, L59-L63 (15 Apr 1974).

The Perseus cluster of galaxies has been studied with 0.5–1.5 keV and 1.0–3.1 keV grazing-incidence X-ray telescope systems on the Orbiting Astronomical Observatory, Copernicus. Observations with a range of apertures (12′, 6′, and 2′) defining the field of view reveal the presence of a compact X-ray source centered 35′±30′ north of NGC 1275. This has less than 3′ extent, and we identify the X-ray source with NGC

1275. The core of the extended cluster emission observed with Uhuru is also detected. If it is assumed that the cluster core X-ray emission distribution is independent of energy, then the X-ray intensity of NGC 1275 is 10–25 percent of the total cluster emission, and may have a similar spectrum. We therefore deduce a 0.5–1.5 keV X-ray luminosity of either 1×10^{44} or 2.5×10^{44} ergs s^{-1} (H_0=50 km s^{-1} Mpc^{-1}) for NGC 1275. We discuss the isothermal gas sphere model for the cluster core, provide upper limits in the 0.5–1.5 keV range for NGC 1265 and IC 310 which are within the cluster, and consider the compatibility of our results with other published data. (auth)

13569 A BLUE GALACTIC NUCLEUS WITH A FEATURELESS SPECTRUM. Khachikian, E.Y. (Byurakan Astrophysical Observatory, Armenia, USSR); Weedman, D.W. Astrophys. J. Lett. 189: No. 3, L99-L100 (1 May 1974).

The galaxy Markarian 501 is found to have a bright blue nucleus with colors very similar to those of the Seyfert galaxy NGC 1275. The spectrum of the nucleus of Markarian 501 appears featureless, however, so it may be related to objects such as BL Lacertae which have featureless, nonthermal spectra. Markarian 501 is within 3′ of the listed position of the radio source 4C 39.49. (auth)

13570 STRUCTURE OF THE LOCAL GALACTIC MAGNETIC FIELD. Manchester, R.N. (Department of Physics and Astronomy, University of Massachusetts, Amherst, Massachusetts 01002). Astrophys. J. 188: No. 3, 637-644 (15 Mar 1974).

Rotation measures have been determined for 18 pulsars, which brings the total number known to 38. It is concluded from these results that the magnetic field in the local region consists of a longitudinal component of strength 2.2 ± 0.4 microgauss directed toward $l=94°\pm11°$, together with superposed irregularities of comparable field strength. The longitudinal component appears to be uniform on a large scale, having the same sense and direction out to more than 1 kpc from the Sun. Scales of irregularities are typically a few hundred parsecs, with smaller-scale structure apparently not an important contribution to the average field. These conclusions are compared with those from observations of rotation measures of extragalactic sources and optical polarization, and their implications on proposed models for the origin of the galactic field are discussed. (auth)

13571 NEBULAR PHOTOMETRY WITH AN ECHELLE SPECTROMETER: [O III] LINE RATIOS IN NGC 1976 AND NGC 6853. Bohuski, T.J.; Dufour, R.J.; Osterbrock, D.E. (Washburn Observatory, University of Wisconsin, Madison). Astrophys. J. 188: No. 3, 529-532 (15 Mar 1974).

Results are presented for measurements of the [O III] λ5007/λ4363 intensity ratio in NGC 1976, NGC 6853, NGC 650-1, and several small planetary nebulae. The temperatures computed from this ratio are typically 12,000°K in NGC 6853 and 9000°–12,000°K in NGC 1976. In the latter nebula, temperatures are found to increase with increasing distance from the Trapezium. (auth)

13572 VARIABLE N GALAXIES AS COMPOSITE SYSTEMS. Adams, T.F. (Yerkes Observatory, University of Chicago, Williams Bay, Wisconsin). Astrophys. J. 188: No. 3, 463-468 (15 Mar 1974).

Procedures are developed on the basis of Sandage's composite N galaxy model for interpreting the trajectories traced out by variable N galaxies in the color-color diagram. These procedures are shown to give reasonable results when applied to published data for the N galaxies 3C 390.3 and PKS 0521-36. The same procedures are then applied to published data for the peculiar variable BL Lac. The lack of observable spectral features is still unexplained. Otherwise, the results are consistent with the identification of BL Lac as a composite N galaxy at $z\simeq0.022$. (auth)

13573 DYNAMICAL FRICTION IN GRAVITATIONAL SYSTEMS. Ahmad, A.; Cohen, L. (Hunter College of the City University of New York). Astrophys. J. 188: No. 3, 469-471 (15 Mar 1974).

Results of numerical experiments are presented showing the existence of dynamical friction in gravitational systems. Comparisons are made with the theory of Chandrasekhar and von Neumann. (auth)

13574 HELIUM ABUNDANCE AT THE GALACTIC CENTER. Jura, M. (Princeton University Observatory); Wright, E.L. Astrophys. J. 188: No. 3, 473-474 (15 Mar 1974).

We suggest that the low abundance of ionized helium in H II regions at the galactic center can be explained by selective absorption of helium-ionizing photons by dust within the ionized gas. This model requires an extrapolation to 500 Å of the rapid increase of the extinction measured between 1500 Å and 1000 Å with the Copernicus satellite, and it assumes that the dust absorbs most of the Lyman continuum. (auth)

13575 THE He^+/H^+ RATIO IN DARK CLOUDS. Brown, R.L. (National Radio Astronomy Observatory, Green Bank, West Virginia); Gómez-González, J. Astrophys. J. 188: No. 3, 475-480 (15 Mar 1974).

The relative abundance of the ions He^+ and H^+ in dark clouds is determined by interaction with many atomic and molecular species so that the ratio $n(He^+)/n(H^+)$ may be quite different from what is expected in tenuous H II regions. We demonstrate that in clouds having temperatures $T\gtrsim100°$ K the ratio $n(He^+)/n(H^+)$ may exceed unity, independent of the source of ionization, as a result of H^+ neutralization via the charge-transfer reaction $O+H^+\rightarrow O^+H$. At lower temperatures, T=20°K, where the rate for this reaction is negligible, $n(He^+)/n(H^+)$ <1 percent for regions with electron densities typical of dark clouds $n_e/n\sim10^{-5}$; again this result holds irrespective of the source of ionization. We conclude that use of the observational $n(He^+)/n(H^+)$ ratio to discriminate between cosmic-ray and X-ray ionization of the interstellar medium is highly unreliable unless all the physical parameters of the recombination line region are precisely known. (auth)

13576 OPTICAL INTERSTELLAR LINE STUDIES OF A NEARBY COLD CLOUD. Crutcher, R.M. (Owens Valley Radio Observatory, California Institute of Technology); Riegel, K.W. Astrophys. J. 188: No. 3, 481-488 (15 Mar 1974).

Interstellar Ca II lines in the spectra of OB stars in a large region toward the galactic center are shown to arise in the cold hydrogen cloud seen in self-absorption in the 21-cm line. The distances of two of these stars are 150 and 180 pc, which are thus upper limits to the cloud distance. The cold hydrogen is almost certainly associated with the dust at about 150 pc distance which covers this entire area. OH molecules have been detected in this dust at the same velocity as the cold H I. The cold hydrogen is arranged in sheets with multiple velocity components; density fluctuations within these sheets have a typical scale size of about 5 pc, which is the probable thickness of the sheets. The cloud extends for at least 100 pc along the galactic plane and at least 30 pc perpendicular to it. From a comparison of interferometric H I absorption profiles, single-dish emission profiles, and optical Na I line data the set T = 40° K, $n(H)=20\ cm^{-3}$, n(e) = 0.05 cm^{-3} is derived for one position in the cloud; these values compare very well with predictions of the two-phase model of the interstellar medium. An unexpectedly wide Na I D_2 line profile may be explained either as the effect of multiple weak cold-cloud components or as an intermediate temperature (~800°K) intercloud medium. (auth)

13577 THE POSSIBLE RELATION OF THE 3-KILOPARSEC ARM TO EXPLOSIONS IN THE GALACTIC NUCLEUS. Sanders, R.H.; Prendergast, K.H. (Columbia University). Astrophys. J. 188: No. 3, 489-500 (15 Mar 1974).

One- and two-dimensional hydrodynamical calculations have been carried out in order to simulate the effects of an energetic explosion in the center of the Galaxy. In both cases the galactic gravitational field, differential rotation, and radiative cooling were approximately simulated. The essential result is that a radially oscillating ring of cold gas is produced in galactic plane and that this oscillation persists for some time longer than the initial expansion time of the hot gas. The mean distance of this oscillating ring from the galactic center is dependent upon the explosion energy. In order to produce such a ring at the location of the 3-kpc arm, the explosion of a central mass of 4×10^8 $M_\odot$ with a total explosion energy of 3×10^{54} ergs is required. Very little gas is left between the ring and the galactic center. These results are discussed with regard to their possible relevance to the observed 3-kpc arm. (auth)

13578 THE GALAXY DISTRIBUTION IN THE CLUSTER ABELL 2199. Bahcall, N.A. (Princeton University Observatory). Astrophys. J. 186: No. 3, 1179-1188 (15 Dec 1973).

The projected galaxy distribution in the cluster A2199 is measured to four different limiting magnitudes on plates taken with different telescopes and emulsions. The results obtained with the different plates agree well with each other. The galaxy distribution can be described by an Emden isothermal gas sphere model with a core radius of $3'.8=0.10$ Mpc (for $H_0=100$ km s^{-1} Mpc^{-1}). No large effect of mass segregation is observed in the cluster. The mass-to-light ratio of the cluster, determined from a core-fitting technique, is estimated to be $M/L\simeq250\times(H_0/100)$ solar units. (auth)

13579 THE COMPRESSION STRENGTH OF NGC 4321 AND COMPARISON WITH M51. van der Kruit, P.C. (Hale Observatories, Carnegie Institution of Washington). Astrophys. J. 186: No. 3, 807-813 (15 Dec 1973).

Spectra taken with the Cassegrain spectrograph of the Palomar 60-inch and 200-inch telescopes are used to determine the gross properties of the rotation curve of NGC 4321 (M100). From this, rough values for the total mass, the mass-luminosity ratio, and (an upper limit to) the ratio of neutral hydrogen mass to total mass are calculated. The available data indicate strong density-wave compression and show a remarkable similarity to M51. The latter is briefly discussed in terms of the evidence that two parameters determine the set of integral properties, including the compression strength of a galaxy. (auth)

13580 THE INTERPRETATION OF THE DIFFUSE GALACTIC LIGHT. Mathis, J.S. (Washburn Observatory, University of Wisconsin–Madison). Astrophys. J. 186: No. 3, 815-829 (15 Dec 1973).

The equation of transfer has been solved numerically for an infinite cylindrical "spiral arm" containing dust and stars, in order to obtain the scattered diffuse galactic light (DGL) as a function of direction, albedo $\tilde{\omega}$, and phase parameter g (assuming the Henyey–Greenstein phase function). Comparison of the theoretical values of the DFL to Witt's observations leads to values of $\tilde{\omega}$ for any given g. The principal purpose of the study is to find out how sensitive the derived value of $\tilde{\omega}$ is to various parameters, such as the distribution of stars above the plane, τ_z (the optical depth of the Galaxy perpendicular to the plane), etc. Models were calculated with τ_z =0.15–0.286, all of which fit the starlight distribution equally well. Thus τ_z cannot be determined from such models. The uncertainties in the final values of $\tilde{\omega}$ are dominantly observational in spite of the fair range of models tried. The suggested values of $\tilde{\omega}$, for each g, are given in a table. No value of g can be obtained from the DGL, because the quantity which is theoretically dependent on g (the latitude-dependence of the DGL/starlight intensity ratio) is too sensitive to errors in the DGL intensity. (auth)

13581 A STUDY OF THREE GROUPS OF GALAXIES: PLAUSIBLE EXPLANATION OF THE VIRIAL MASS DISCREPANCY. Gott, J.R. III (Department of Astronomy, California Institute of Technology); Wrixon, G.T.; Wannier, P. Astrophys. J. 186: No. 3, 777-785 (15 Dec 1973).

We have made a theoretical and observational study of the de Vaucouleurs groups of galaxies, numbers 6, 12, and 51. With reasonable mass-to-light ratios (i.e., M/L=7 for spirals) these groups show large virial mass discrepancies of the order of $M_{\text{virial theorem}} \sim 400 M_{\text{luminous}}$. We have made 21-cm observations which allow us to place upper limits (3σ confidence level) on the amount of H I present. For bound cluster models we find $M(\text{H I}) < 0.034 M_{VT}, < 0.019 M_{VT}, < 0.035 M_{VT}$ for groups 6,12, and 51, respectively. We discuss some of the difficulties of models in which the clusters are bound by intergalactic gas or are unbound due to ejection of gas in the past. A reasonable explanation of the virial mass discrepancies was found, however. It is that the galaxies in these groups are nothing more than ordinary field galaxies that happen to be nearest neighbors of each other. The groups' velocity dispersions are provided by cosmological expansion. Consider a homogeneous expanding universe. Go out a distance D from us and construct a small sphere of radius r_0. Treating the galaxies within this sphere as constituting a group, one finds $M_{VT} = (q_0^*)^{-1} M_L$, where $q_0^* = (\rho_{\text{luminous}}/2\rho_{\text{crit}})$ is the contribution to the Universe's deceleration parameter made by luminous galaxies. With Shapiro's estimate of $q_0^* \simeq 0.005$ one predicts $M_{VT} \simeq 200 M_L$, in reasonable agreement with the observed values. (auth)

13582 INFRARED SOURCES IN SHARPLESS 228. Frogel, J.A.; Perrson, S.E. (Harvard College Observatory, Cambridge, Massachusetts). Astrophys. J. 186: No. 1, 207-210 (15 Nov 1973).

Infrared photometry from 1.65 to 20 μ of the optical nebula Sharpless 228 indicates the pressure of a compact (<5") emission region within an extended region of low but uniform surface infrared brightness. The flux density of the compact source rises steeply from 1.65 to 3.5 μ and somewhat less so from 3.5 to 20 μ. The compact source is associated with a stellar-like optical object having emission lines of Hα and [N II] and suffering from considerable extinction. It appears to be a compact H II region. (auth)

13583 OPTICAL INTERSTELLAR LINES IN DARK CLOUDS. Cohen, J.G. (Berkeley Astronomy Department, University of California, Berkeley). Astrophys. J. 186: No. 1, 149-163 (15 Nov 1973).

Observation of the equivalent widths and radial velocities of the interstellar line of Ca II, Na I, CH, and CH^+ are presented for 30 stars. A special effort was made to observe stars behind or within dense clouds with up to 3 mag of absorption. The interstellar lines in the cloud stars are compared with those in a group of highly reddened supergiants whose reddening arises from a large distance, i. e., a long path length through relatively thin material. The atomic interstellar lines of the cloud stars are weak compared to those of superigants with the same color excess; the molecular lines are of comparable strength in the two groups, except that the ratio n_{CH}/n_{CH^+} is larger in the cloud stars. The ionization equilibrium is discussed, and it is concluded that the deficiency of atomic Ca and Na relative to hydrogen in the clouds is about a factor of 100 larger than in the supergiants. (auth)

13584 KINETIC ENERGY IN THE SPONTANEOUS RADIATIVE DISSOCIATION OF MOLECULAR HYDROGEN. Stephens, T.L. (General Electric-TEMPO, Santa Barbara, California); Dalgarno, A. Astrophys. J. 186: No. 1, 165-167 (15 Nov 1973).

The fluorescent photodissociation of molecular hydrogen produces energetic atoms and may be a significant heat source in interstellar clouds. A table is presented of the average kinetic energies carried by the product hydrogen atoms in the spontaneous radiative dissociation $H_2' \rightarrow H + H + h\nu$ of the vibrational levels of the excited hydrogen molecule H_2' for the Lyman and Werner systems. The calculation has been performed also for the Lyman system of HD and D_2. The kinetic energies of the dissociated pair of hydrogen atoms range from approximately 0.04 to 1 eV. (auth)

13585 ROCKET-INFRARED OBSERVATIONS OF THE GALACTIC CENTER. Soifer, B.T.; Houck, J.R. (Center for Radiophysics and Space Research, Cornell University). Astrophys. J. 186: No. 1, 169-176 (15 Nov 1973).

Observations of the galactic center region, made at 5, 13, 20, and 100 μ with the Cornell liquid-helium rocket telescope, are reported. It is shown that the infrared source at 13 and 20 μ is much larger than previous ground-based measurements had reported. The large luminosity of the source at 100 μ is confirmed. One mechanism that can easily account for the observations of the extended source is thermal emission from dust grains. Two models for heating the dust in the extended region around the galactic center are considered. (auth)

13586 PHYSICAL CONDITIONS IN THE NUCLEI OF M51, M81, AND M64. Warner, J.W. (Department of Astronomy and Radio Observatory, The Ohio State University, Columbus). Astrophys. J. 186: No. 1, 21-34 (15 Nov 1973).

Spectra of the semistellar nuclei of M51, M81, and M64 in the range 3500–6900 Å taken with a skylight suppressor are presented along with emission-line strengths. Limits on electron temperatures and ranges of electron densities are calculated from emission-line intensity ratios and compared for two different aperture sizes corresponding to 2".5 and 6'. The estimated values of the densities are higher than previously published values, and some evidence for a density gradient is found. In M51, the [N II]/Hα line ratio is an order of magnitude greater in the nucleus than it is 30" away from the nucleus. Similar but smaller changes appear in M81. Calculated abundances for nitrogen and sulfur imply large abundance excesses compared to GMA solar values for the nuclei of M51 and M81 if in fact no other physical explanation is the cause of the change of the [N II]/Hα ratio with a distance from the nucleus. Changes in the oxygen [O II] line strength with distance in M51 and calculated lower limits to the Hα/Hβ ratios in both M51 and M81 imply the possible existence of absorption in the nucleus and demonstrate the crucial role that absorption-free line ratios play in the "overabundance problem". (auth)

13587 ANALYTICAL APPROXIMATIONS TO THE EVOLUTION OF GALAXIES. Tinsley, B.M. (Astronomy Program and Center for Theoretical Physics, University of Maryland). Astrophys. J. 186: No. 1, 35-49 (15 Nov 1973).

Analytical expressions are derived for the evolution of the luminosity, mass of stars, mass of invisible remnants, rate of ejection of gas from stars, and yield of heavy elements in idealized model galaxies. The equations are based on simple assumptions concerning the mass function of star formation and stellar evolution, and they apply to an arbitrary time-dependence of the stellar birthrate. Especially simple and instructive forms are derived for the expressions in the cases where star formation occurs uniformly and where it occur in an initial burst. These results are used to show how certain properties of elliptical galaxies, globular clusters, and late-type galaxies depend on parameters characterizing their rate of star formation and the initial mass function. In spite of the severe limitations of this approach to galactic evolution, it sheds light on the results obtained from detailed numerical models, and it predicts a number of useful general relationships among galactic properties. (auth)

13588 THE EVOLUTION OF GALAXIES. II. CHEMICAL EVOLUTION COEFFICIENTS. Talbot, R.J. Jr. (Department of Space Physics and Astronomy, Rice University, Houston); Arnett, W.D. Astrophys. J. 186: No. 1, 51-67 (15 Nov 1973).

We presented a detailed analysis of how stellar evolution determines the coefficients in theories of the chemical evolution of galaxies. With these coefficients, it is possible to make comparisons with observed abundances; these comparisons are insensitive to the history of the total stellar birthrate. From a detailed examination of numerical stellar evolutionary sequences we evaluate these coefficients. The agreement with observation is excellent. (auth)

13589 THE EVOLUTION OF GALAXIES. III. METAL-ENHANCED STAR FORMATION. Talbot, R.J. Jr. (Institute of Theoretical Astronomy, Cambridge, England); Arnett, W.D. Astrophys. J. 186: No. 1, 69-89 (15 Nov 1973).

The problem of the paucity of low-metal-abundance low-mass stars is discussed. One alternative to the variable-initial-mass function (VIMF) solution is proposed. It is shown that this solution—metal-enhanced star formation—satisfies the classical test which prompted the VIMF hypothesis. Furthermore, with no additional parameters it provides improved fits to other tests—e.g., inhomogeneities in the abundances in young stars, concordance of all nucleo-cosmochronologies, and a required yield of heavy-element production which is consistent with current stellar evolution theory. In this model the age of the Galaxy is $18.6 \pm 5 \times 10^9$ years. (auth)

13590 PHOTOMETRIC STRUCTURE OF THE SPIRAL GALAXIES NGC 3351, 4051, 4618, AND 4826. Vorontsov-Vel'yaminov, B.A.; Savel'eva, M.V. (Shternberg Astronomical Institute, Moscow). Sov. Astron.-AJ 17: No. 5, 643-646 (Mar 1974).

Detailed photometry at blue wavelengths is reported for four spiral galaxies which are interesting in several respects. The first has a hot complex nuclear region; the second is a Seyfert galaxy; the third may comprise a pair of systems in close interaction; and the last, with a

very prominent dust layer, has the highest surface brightness among spirals. (auth)

13591 COMPACT GALAXIES IN THE NEIGHBORHOOD OF THE ANDROMEDA NEBULA. Sharov, A.S. (Shternberg Astronomical Institute, Moscow). Sov. Astron.–AJ 17: No. 5, 647-650 (Mar 1974).

Fifty diffuse objects in the neighborhood of the Andromeda Nebula with color indices $B-V > 1^{m}.0$ have been identified on plates taken with the Schmidt telescope of the Latvian Radio Astrophysical Observatory at Baldone. The objects show no concentration toward the galaxy, they represent distant compact galaxies. Their large color indices appear to be real and are not caused wholly by red shift. (auth)

13592 RELATION BETWEEN THE BASIC PARAMETERS OF THE FLAT AND SPHERICAL SUBSYSTEMS OF GALAXIES. Morozov, A.G.; Fridman, A.M. (Siberian Branch, Institute of Terrestrial Magnetism, the Ionosphere, and Radio-Wave Propagation, Academy of Sciences of the USSR). Sov. Astron.–AJ 17: No. 5, 651-654 (Mar 1974).

A heterogeneous flat-galaxy model comprising spherical and flat subsystems is discussed. In accordance with observational data a rather wide class of functions is specified to describe the volume density in the spherical subsystem and the rotational velocity of the flat component. The surface density of the rotating flat subsystem is calculated from the equilibrium condition. In all cases considered, the surface density of the flat component declines exponentially beyond the nucleus of the spherical component. The dependence of the exponent on the relative size of the nucleus agrees qualitatively with Freeman's observations. A power-law relation is established between the total mass and angular momentum of the flat component; in all cases the exponent ν in this law is confined to the narrow range $1.6 \leq \nu \leq 1.8$. (auth)

13593 PARAMETERS OF THE VELOCITY DISTRIBUTION OF MIRA STARS IN THE FLAT, INTERMEDIATE, AND SPHERICAL SUBSYSTEMS OF THE GALAXY. Gotska, T.G. (Rostov-on-Don Teachers' College). Sov. Astron.–AJ 17: No. 5, 655-658 (Mar 1974).

The centroid velocity, velocity dispersion, and Planck-function parameter C are calculated for Mira-type variables with $r < 1$ kpc. Stars belonging to the flat ($P < 150^{d}$, $P > 400^{d}$), intermediate ($P = 200$–400^{d}), and spherical ($P = 150$–200^{d}) subsystems of our galaxy are treated separately. The lag velocity $-\bar{v}_{\theta}$ relative to galactic rotation and the mean velocity dispersion $\bar{\sigma}$ of the subsystems agree with Strömberg's empirical formula. (auth)

13594 INTENSITY OF H_2^* RADIO LINES IN THE INTERSTELLAR MEDIUM. Ruzmaikina, T.V. (Moscow Technical Physics Institute). Sov. Astron.–AJ 17: No. 5, 594-597 (Mar 1974).

The expected intensity for radio lines of highly excited hydrogen molecules with $n > l \gg 1$ is estimated. H_2^+ ions are the main source of supply for H_2^*; they will form when ultraviolet radiation ionizes molecules from vibrational levels $v \geq 3$ of the ground state. The H_2^+ density will be proportional to the ultraviolet flux F if $F < F_c \simeq 10^{-4}$–10^{-3} photon/cm^2-sec-Hz, but independent of F if $F > F_c$. H_2^* radio lines strong enough to be observable would be expected from dense clouds of low electron temperature located near compact H II zones associated with early-type stars. The position and shape of the H_2^* lines are discussed. (auth)

13595 MATHEMATICAL FORM OF SPIRAL ARMS. Sakharova, E.S. (Shternberg Astronomical Institute, Moscow). Sov. Astron.–AJ 17: No. 5, 693-694 (Mar 1974).

The shape of the spiral arms in 14 highly regular galaxies is investigated. Danver's statistical finding that the arms are better represented by a logarithmic than an Archimedean spiral is confirmed, contrary to the Karachentsevs' results. (auth)

Cosmology

Refer also to abstracts 13407 and 13500.

13596 HAMILTONIAN COSMOLOGY: DEATH AND TRANSFIGURATION. Ryan, M.P. Jr. (Center for Relativity Theory, The University of Texas at Austin, Austin, Texas 78712). J. Math. Phys. (N.Y.) 15: No. 6, 812-815 (June 1974).

Following work of MacCallum and Taub, we show that for Bianchi-type universes of Ellis–MacCallum class B (Bianchi types II, III, IV, V, $VI_{h=-1}$, $VII_{h=0}$) Hamiltonian cosmology breaks down. We construct a quasi-Hamiltonian theory for these models. (auth)

13597 OBSERVATIONS IN LOCALLY INHOMOGENEOUS COSMOLOGICAL MODELS. Dyer, C.C. (David Dunlap Observatory, University of Toronto); Roeder, R.C. Astrophys. J. 189: No. 2, 167-176 (15 Apr 1974).

Locally inhomogeneous "Swiss cheese" cosmological models have been extended to the cases in which the cosmological constant is nonzero. Application of the optical scalar equations in such models has yielded estimates of the distortions of distant objects and revised distance-redshift relations. Results of numerical integrations also show that in the Friedmann models the "zero shear" models previously discussed by us yield a good approximation as far as observational quantities are concerned. (auth)

13598 ON GRAVITATIONAL-LENS QUASARS. de Silva, L.N.K. (Department of Mathematics, University of Sri Lanka, Peradeniya Campus, Sri Lanka (formerly Ceylon)). Astrophys. J. 189: No. 2, 177-180 (15 Apr 1974).

It is shown that the intensification due to a transparent gravitational lens is inadequate for quasars to be gravitational-lens images of Seyfert nuclei. (auth)

13599 THE GRAVITATIONAL-INSTABILITY PICTURE AND THE NATURE OF THE DISTRIBUTION OF GALAXIES. Peebles, P.J.E. (Physics Department, University of California, Berkeley). Astrophys. J. Lett. 189: No. 2, L51-L53 (15 Apr 1974).

The convariance function for the distribution of galaxies is close to a power law, exhibiting no characteristic scales or features, over a broad range of the argument. This has a simple interpretation in the gravitational-instability picture for the evolution of irregularities in an expanding universe. A prediction for a new test of the picture is described. (auth)

13600 THE HUBBLE RELATION FOR NONSTANDARD CANDLES AND THE ORIGIN OF THE REDSHIFT OF QUASARS. Petrosian, V. (Institute for Plasma Research and Department of Applied Physics, Stanford University, Stanford, California). Astrophys. J. 188: No. 3, 443-449 (15 Mar 1974).

It is shown that the magnitude-log (redshift) relation for brightest quasars can have a slope different from the value expected for standard candles. The value of this slope depends on the luminosity function and its evolution. Therefore the difference of this slope from the expected value cannot be used as evidence against the cosmological origin of the redshift of the quasars. It is shown that the observed variation of the luminosity of the brightest objects with redshift is consistent with the cosmological hypothesis and that it agrees with (and perhaps could be used to complement) the luminosity function obtained from V/V_m analysis. It is also shown that the nonzero slope of the magnitude-log (redshift) relation rules out the local quasar hypothesis, where it is assumed that the sources are nearby ($\lesssim 500$ Mpc), that the bulk of their redshift is intrinsic, and that there is no dependence on distance of the intrinsic properties of the sources. (auth)

13601 EMPIRICAL PROPERTIES OF THE MASS DISCREPANCY IN GROUPS AND CLUSTERS OF GALAXIES. II. Rood, H.J. (The Institute for Advanced Study, Princeton, New Jersey 08540). Astrophys. J. 188: No. 3, 451-461 (15 Mar 1974).

Data compiled by de Vaucouleurs, Karachentsev, Holmberg, Burbidge and Sargent, and others show that the mass ratio (ratio of virial-theorem mass to luminous mass) of groups and clusters is generally correlated with radius and velocity dispersion. "Solar-system-type" groups have mass ratios (derived with a two-body formula) which increase with projected velocity and distance of a secondary galaxy relative to the primary galaxy. The non-Doppler redshift hypothesis to resolve the mass discrepancy problem is examined. (auth)

13602 A QUANTITATIVE ALTERNATIVE TO THE COSMOLOGICAL HYPOTHESIS FOR QUASARS. Bell, M.B.; Fort, D.N. (Astrophysics Branch, National Research Council of Canada, Ottawa). Astrophys. J. 186: No. 1, 1-19 (15 Nov 1973).

This paper examines the possibility that quasars may be located somewhere between the two distance extremes suggested by the "cosmological" and "local" hypotheses. Using the apparent magnitude and the Hubble relation, we have calculated the distance component of the redshift for different absolute magnitude values, and find, for radio quasars, that the excess redshift is quantized for one particular absolute magnitude value. The distance redshift components derived using this particular absolute magnitude lie in the range 0–0.3 and have been included in a table. We feel that they may represent the true cosmological distance and can thus be used in quantitative analyses which may help us to decide eventually which theory best explains the observational data. We have used the calculated redshift components to examine some of the more fundamental redshift relations and find a consistency between observations and theory that is similar to that obtained for the cosmological hypothesis. Since in most cases the excess redshift is numerically similar to the measured redshift z, in our theory the distance-size relation found for the standard cosmology becomes an intrinsic redshift-size relation with quasars becoming more compact as the excess redshift component increases. Although this theory enjoys any advantages that might be obtained by bringing the quasars nearer (to radio-galaxy distances) while keeping the Hubble relation intact, at the same time it introduces the need to find some explanations for the source of intrinsic redshift. (auth)

13603 INTERGALACTIC DUST: A NEW UPPER LIMIT. Crane, P.; Hoffman, A. (Joseph Henry Laboratories, Physics Department, Princeton University). Astrophys. J. 186: No. 3, 787-790 (15 Dec 1973).

An analysis of the spectral energy distributions of distant galaxies yields a new upper limit on the possible mass in dust particles with sizes less than the wavelength of visible light. The total extinction of the light from galaxies is less than 2.5×10^{-5} mag Mpc^{-1}. The method is reasonably independent of q_0 and of evolution and may show promise for future investigations. (auth)

Planetary Phenomena

13604 THE MICROWAVE PROPERTIES OF SATURN'S RINGS. Briggs, F.H. (National Astronomy and Ionosphere Center, Cornell University, Ithaca, New York 14850). Astrophys. J. 189: No. 2, 367-377 (15 Apr 1974).

Radio interferometer observations at 1420, 2695, and 8085 MHz show that the ring particles are nearly lossless at microwave frequencies. The microwave brightness temperature of the rings is less than 20° K. The ability of the rings to obscure part of Saturn's disk indicates that most of the particles must be larger than 5 cm in diameter. A model assuming particles of water ice is consistent with the radio interferometer, radar, and millimeter wave observations. (auth)

13605 STABLY TRAPPED PROTON FLUXES IN THE JOVIAN MAGNETOSPHERE. Coroniti, F.V. (Department of Physics, University of California, Los Angeles, California 90024); Kennel, C.F.; Thorne, R.M. Astrophys. J. 189: No. 2, 383-388 (15 Apr 1974).

A model of the energetic proton fluxes in the Jovian magnetosphere is constructed based on the inward radial diffusion of protons from the solar wind and the plasma turbulent precipitation loss of protons from the radiation belts. Outside 12 Jovian radii (R_J) the proton fluxes follow a loss-free radial diffusion profile. Inside 12 R_J the proton fluxes should be near the stably trapped limit flux set by convective marginal stability to the electromagnetic ion cyclotron wave ($7 \leq L \leq 12$) and the quasi-electrostatic ion loss-cone wave ($1.5 \leq L \leq 5$). (auth)

13606 INFRARED OBSERVATIONS OF COMET KOHOUTEK NEAR PERIHELION. Ney, E.P. (School of Physics and Astronomy, University of Minnesota, Minneapolis, Minnesota 55455). Astrophys. J. Lett. 189: No. 3, L141-L143 (1 May 1974).

Observations between 0.55 and 18 μ show that after perihelion passage comet Kohoutek possessed an infrared tail and antitail. The coma and the tail have the silicate signature and contain "black material" which acquires a temperature higher than the blackbody temperature at the given distance from the Sun. The antitail shows the colors of a blackbody at a lower temperature, suggesting that the particles are larger than those in the coma and the tail. (auth)

13607 PARTICLE TRACK RECORD OF APOLLO 16 ROCKS FROM PLUM CRATER. Fleischer, R.L.; Hart, H.R., Jr. (General Electric Research and Development Center, Schenectady, New York 12301). J. Geophys. Res. 79: No. 5, 766-768 (10 Feb 1974).

Particle track measurements in rocks 61016 and 61175 from Plum crater imply that they were intensely shocked $30(\pm10)$ m.y. ago, very likely at the time of formation of the crater. (auth)

13608 GRAVITATIONAL ENERGY SOURCES IN JUPITER. Flasar, F.M. (Center for Earth and Planetary Physics, Harvard University). Astrophys. J. 186: No. 3, 1097-1106 (15 Dec 1973).

Gravitational sources of the intrinsic luminosity of Jupiter are examined in the context of current hydrogen–helium models. When no gravitational separation of matter occurs, the amount of heat which can be released over the remaining lifetime of the planet is necessarily limited by the size of its existing reservoir of thermal energy. This conclusion rests only on the assumption that its interior is relatively cold and degenerate. If gravitational unmixing occurs, the size of the thermal reservoir does not necessarily limit the heat output. If core formation occurs, for example, then the size of the core formed will be a limiting factor. The energy released with the formation of a helium core is computed for Jupiter. A core growth rate averaged over several billion years, of 2×10^{-11} M_J per year is required if gravitational separation is to play a significant role in the thermal evolution. (auth)

13609 PHASE EQUILIBRIA IN MOLECULAR HYDROGEN–HELIUM MIXTURES AT HIGH PRESSURES. Streett, W.B. (Science Research Laboratory, U. S. Military Academy, West Point, New York). Astrophys. J. 186: No. 3, 1107-1125 (15 Dec 1973).

Experiments on phase behavior in hydrogen–helium mixtures have been carried out at pressures up to 9.3 kilobars, at temperatures from 26° to 100°K. Two distinct fluid phases are shown to exist at supercritical temperatures and high pressures. Both the trend of the experimental results and an analysis based on the van der Waals theory mixtures suggest that this fluid–fluid phase separation persists at temperatures and pressures beyond the range of these experiments, perhaps even to the limits of stability of the molecular phases. The results confirm earlier predictions concerning the form of the hydrogen–helium phase diagram in the region of pressure-induced solidification of the molecular phases at supercritical temperatures. The implications of this phase diagram for planetary interiors are discussed. (auth)

13610 EXPERIMENTAL OSCILLATOR STRENGTHS IN THE INFRARED VIBRATION-ROTATION SPECTRUM OF THE HYDROXYL RADICAL. Roux, F.; D'Incan, J.; Cerney, D. (Laboratoire de Spectrométrie Ionique et Moléculaire, Associé au C.N.R.S., Université Claude Bernard, Villeurbanne, France). Astrophys. J. 186: No. 3, 1141-1156 (15 Dec 1973).

We have measured absolute intensities for the transitions of the rotation components of the 1–0, 2–1, 2–0, 3–1, and 4–2 bands in the vibration–rotation spectrum of the OH radical. The spectra were observed in emission from an oxyacetylene flame in thermal equilibrium, using a grill spectrometer equipped with a blackbody. The experimental results are used to calculate oscillator strengths and pure vibration–rotation transition probabilities, and to study the influence of the vibration–rotation interaction. We also give values for the M_1 and M_2 coefficients of the dipole moment expansion for the ground state obtained from our measurements. (auth)

PHYSICS (ATMOSPHERIC)

Auroral and Ionospheric Phenomena

13611 INFRARED PROCESSES IN THE AURORAL ZONE. Bishop, R.H.; Shaw, A.W.; Han, R.Y.; Megill, L.R. (Center for Research in Aeronomy, Utah State University, Logan, Utah 84322). J. Geophys. Res. 79: No. 12, 1729-1736 (20 Apr 1974).

Recently auroral observations have indicated the strong enhancement of certain infrared bands during periods of auroral activity. A theoretical model has been created in order to study the infrared processes associated with the aurora. The quantitative results of this study depend upon a thorough knowledge of the rates of all processes involved. Some of the rate constants are well known, whereas for others we have made only the crudest approximation. Qualitatively, however, our results indicate that certain infrared bands of CO_2, N_2O, NO, and NO^+ are strongly enhanced during periods of auroral activity. This enhancement is primarily the result of two basic energy exchange mechanisms. The energy deposited by the primary auroral electron flux goes into increasing the internal energy of N_2, O_2, and O. That is, the vibrational temperature of N_2 is significantly increased in an aurorally disturbed atmosphere. This energy is then transferred to various infrared active minor constituents such as CO_2, N_2O, NO, etc. through near-resonant vibrational-vibrational exchange processes, increasing the high-level vibrational populations of these species and thereby enhancing their infrared radiative output. In addition to energetic auroral particles as an energy source we have also considered electric fields. Qualitatively the results are similar except that the energy tends to be deposited at altitudes somewhat higher than those in direct precipitation processes. (auth)

13612 ELECTRON AND ION TEMPERATURE, ELECTRON CONCENTRATION, AND RECOMBINATION IN THE IONOSPHERE AT MEDIUM LATITUDES DURING HIGH SOLAR ACTIVITY BY MEASUREMENT OF THE INCOHERENT SCATTERING. Misyura, V. O.; Erokhin, Yu. G.; Trukhan, M. G.; Bludov, V. Ya.; Ivanov, V. I.; Nisnevich, N. I.; Mashtalir, V. N.; Borodin, N. M.; Kudrev, V. N. Visn. Kharkiv. Univ., Radiofiz.; No. 92, 3-11(1973). (In Ukrainian).

The results of atmospheric measurements carried out by the method of incoherent scattering were reported for the electron concentration, electron temperature, and ion temperature at medium latitudes of the Soviet Union during periods of high solar activity. (tr-auth)

13613 THEORY AND CALCULATION OF THE EFFECTS ARISING DURING PROPAGATION OF RADIOWAVES IN GYROTROPIC THREE-DIMENSIONAL NON-HOMOGENEOUS QUASISTATIONARY PLASMA NEAR THE GROUND. Misyura, V. O.; Bazhanov, G. M.; Stasenko, V. D.; Krokhmal'nikov, E. B.; Naboka, A. M.; Barkov, A. D.; Kapanin, I. I.; Pushin, V. F.; Ribalka, A. I. Visn. Kharkiv. Univ., Radiofiz.; No. 92, 11-25(1973). (In Ukrainian).

The theory, methods, and results of the calculation and analysis of effects arising during the propagation of KX and YKX in gyrotropic three-dimensional non-homogeneous quasistationary plasma near the ground are reported in the radial approximation. (tr-auth)

13614 CALCULATION FOR THE WAKE OF A SMALL CYLINDER UNDER IONOSPHERIC SATELLITE CONDITIONS. Woodroffe, J.A.; Sonin, A.A. (Department of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). Phys. Fluids 17: No. 1, 79-82 (Jan 1974).

A method is outlined for the calculation of the wakes of small cylinders in hypersonic, collision-free, cold-ion plasma flow. No applied magnetic field is considered. Results are presented for a cylinder with a radius of 0.005 Debye lengths in a flow with a Mach number (based on the ion-acoustic speed) of 8, and a comparison is made with available experimental data. (auth)

13615 OBSERVATIONS OF RADIATION FROM AN ELECTRON BEAM ARTIFICIALLY INJECTED INTO THE IONOSPHERE. Cartwright, D.G.; Kellogg, P.J. (School of Physics and Astronomy, University of Minnesota, Minneapolis, Minnesota 55455). J. Geophys. Res. 79: No. 10, 1439-1458 (1 Apr 1974).

This paper reports the observations of waves generated by a controlled beam of particles artifically injected into the ionosphere and magnetosphere. The measurements were made during the Electron Echo 1 experiment, in which an electron accelerator was carried to a height of 350 km in the ionosphere from Wallops Island, Virginia, on an Aerobee 350 sounding rocket. It injected into the earth's magnetic field over 3000 16-ms pulses of electrons with 40-keV energy and a current of 70 mA at pitch angles between 70° and 110°. The ejected fiber glass nose cone carried antennas and receivers to measure the electric field of waves generated by the beam. Associated with the electron beam was radiation detected at frequencies near the electron plasma frequency of the background ionosphere, near twice the electron cyclotron frequency in the whistler mode, and near zero frequency. Associated with the operation of an argon plasma generator used to keep the accelerator neutralized were continuous emissions detected at frequencies near the lower-hybrid resonance (LHR). All of these wave modes have low phase velocities and hence can interact strongly with particles emitted from the rocket. A surprising result is that the amplitude of many of the emissions reaches a peak a few milliseconds after the start of a gun pulse and then falls to a much lower value, roughly consistent with incoherent emission, by end of the pulse. The amplitude of the emissions at the LHR frequency and the electron cyclotron harmonic can only be accounted for by instabilities or coherent emission. The beam loses no significant power to waves, and close to the rocket, radiation does not play an important part in the dynamics of the beam generation. Even so, many wave modes can be observed at distances up to a few kilometers from the beam. No radiation from electrons returning from the conjugate region was detected, and no radiation associated with the experiment was detected on the ground. (auth)

13616 A NEW MODEL FOR THE INTERACTION OF AURORAL ELECTRONS WITH THE ATMOSPHERE: SPECTRAL DEGRADATION, BACKSCATTER, OPTICAL EMISSION, AND IONIZATION. Banks, P.M.; Chappell, C.R. (Lockheed Palo Alto Research Laboratory, Palo Alto, California 94304); Nagy, A.F. J. Geophys. Res. 79: No. 10, 1459-1470 (1 Apr 1974).

A new computational model has been created to describe the interaction of auroral electrons with the atmosphere. For electrons of energy greater than 500 eV, continuous energy losses and small angle deflections are combined in a Fokker-Planck diffusion equation that computes energy spectrums over all pitch angles throughout the atmosphere. These fluxes are then used to determine the rates of secondary electron and degraded ($E < 500$ eV) primary electron production at all heights. This information is used to compute upward and downward hemispherical fluxes in the energy range 0-500 eV, taking into account discrete energy losses, large angle scattering, and particle transport along magnetic field lines. The model has been used to compute energy spectrums, ionization rates, backscatter ratios, and optical emissions associated with different incident electron spectrums. For monoenergetic electrons of energy 2 keV and above the results obtained agree well with the work of Rees (1969) and Rees and Maeda (1973). At lower energies the effects of transport and elastic collisions become progressively more important, and the present results differ significantly both from the Rees and Maeda results and from those obtained from the ideas of energy degradation. Finally, spectrums typical of the nighttime auroral oval and daytime polar cusp are used to obtained the altitude dependent fluxes, ionization rates, and optical emissions. (auth)

13617 IN SITU MEASUREMENTS OF THE SPECTRAL CHARACTERISTICS OF F REGION IONOSPHERIC IRREGULARITIES. Dyson, P.L.; McClure, J.P.; Hanson, W.B. (University of Texas at Dallas, Dallas, Texas 75230). J. Geophys. Res. 79: No. 10, 1497-1502 (1 Apr 1974).

The retarding potential analyzer aboard Ogo 6 has provided high-resolution observations of the ion concentration along the satellite path. Changes in ion concentration as small as 0.03% and at times as small as 0.01% could be measured. Spatial resolution varied from 35 to 380 m. Samples of data have been analyzed to determine the spectral properties of the F region irregularities observed. The most common frequency spectrum observed follows to a very good approximation a power law of the form $Af^{-n} \alpha S^n$, where A is the irregularity amplitude, f is the observed frequency, and S is the irregularity scale size. The spectrum was measured over the scale size range 70 m to 7 km, and the values of n obtained were close to 1, the average value being 0.95. The spectral index n is found to be insensitive to irregularity amplitude. This type of spectrum suggests that the irregularities in this scale size range result from the turbulent dissipation of larger irregularities. At the equator the larger irregularities are probably produced by convective electric fields. At high latitudes, electric field may also be involved, but other factors such as precipitating particles may contribute to, or be primarily responsible for, the production of large irregularities. Examples of other types of spectra associated with wavelike irregularities with the 'ground glass' (high-frequency noise) irregularities are also shown. (auth)

13618 LOW-ALTITUDE ACCELERATION OF AURORAL ELECTRONS DURING BREAKUP OBSERVED BY A MOTHER-DAUGHTER ROCKET. Johnstone, A.D. (Mullard Space Science Laboratory, Holmbury St. Mary, Surrey, England); Davis, T.N. J. Geophys. Res. 79: No. 10, 1416-1425 (1 Apr 1974).

By the use of a mother-daughter rocket combination and

ground-based observations with television, time and space variations are resolved in particle measurements in breakup aurora. The spectral variations measured during a temporal variation in the aurora can be explained by a nearly uniform acceleration of all the electrons such as would be caused by an electric potential drop along the magnetic field lines. Many other explanations can be eliminated. (auth)

13619 AURORAL SUBSTORMS OBSERVED FROM ABOVE THE NORTH POLAR REGION BY A SATELLITE. Snyder, A.L. (Air Force Global Weather Central, Air Weather Service, Offutt Air Force Base, Nebraska 68113); Akasofu, S.I.; Davis, T.N. J. Geophys. Res. 79: No. 10, 1393-1402 (1 Apr 1974).

High-resolution scanner images of auroras obtained by a Dapp satellite flown by the United States Air Force provide new insights into auroral morphology. Images obtained during an active period, January 25 and 26, 1973, confirm the general validity of the concept of the auroral substorm. In addition, the images clearly show such morphological features as the shift of initial brightening toward the dusk sector during disturbed periods, predominance of discrete auroras in the evening sector, the latitudinal separation of discrete and diffuse auroras, and the merging of some polar cap auroras with auroras in the oval. (auth)

13620 ANOMALOUS RESISTIVITY IN THE AURORAL PLASMA. Papadopoulos, K. (University of Maryland, College Park, Maryland 20742); Coffey, T. J. Geophys. Res. 79: No. 10, 1558-1561 (1 Apr 1974).

It is shown that the low-frequency ion density fluctuations produced nonlinearly by the interaction of fast precipitating electrons with the auroral plasma can enhance the resistivity of the auroral plasma by several orders of magnitude over its collisional value. (auth)

13621 ROCKET MEASUREMENT OF Sq IONOSPHERIC CURRENTS OVER KAGOSHIMA, JAPAN. Yabuzaki, T.; Ogawa, T. (Ionosphere Research Laboratory, Kyoto University, Kyoto, Japan). J. Geophys. Res. 79: No. 13, 1999-2001 (1 May 1974).

We report on the results of rocket measurement of the mid-latitude Sq currents. The magnetic sensor used was a self-oscillating scalar magnetometer with cesium vapor. The measurement was carried out by the K-9M-32 rocket flown at 1542 LT on September 27, 1970, from Kagoshima Space Center (131°41'E, 31°15'N, geomagnetic latitude 19.8°N). The flight time was about 10 min, and the peak altitude was 347 km. (AIP)

13622 ELECTRIC AND MAGNETIC FIELDS MEASURED DURING A SUDDEN IMPULSE. Schutz, S. (Aeronomy Laboratory, Department of Electrical Engineering, University of Illinois, Urbana, Illinois 61801); Adams, G.J.; Mozer, F.S. J. Geophys. Res. 79: No. 13, 2002-2004 (1 May 1974).

The electric field in the ionosphere and the magnetic field at the earth's surface in the mid-latitude region were both measured during a sudden impulse. Ionospheric conductivities deduced from this data were consistent with expectations, thus suggesting that the fluctuation in the magnetic field at the earth's surface were caused by overhead ionospheric currents that were driven by an electric field associated with the sudden impulse. (auth)

13623 POLARIZATION OF THE AIRGLOW EMISSION λ6300 IN AN ARTIFICIALLY HEATED IONOSPHERE. Chamberlain, J.W. (Department of Space Physics and Astronomy, Rice University, Houston, Texas 77001). J. Geophys. Res. 79: No. 9, 1239-1242 (20 Mar 1974).

Artifical heating of the ionosphere by powerful injections of radio waves have produced electron excitation of the airglow red line and in some instances the green line of metastable oxygen. If the exciting electrons are preferentially aligned parallel to the magnetic field, the red line will be polarized, except when it is viewed along the field. Observations of the degree of polarization would in turn confirm that there is a high degree of alignment of the fast electrons exciting metastable O, as implied by the parametric plasma instability thought to exist during periods of high energy input. A number of sample calculations for different angular distributions of the exciting electrons are presented. (auth)

13624 PARAMETRIC AMPLIFICATION OF PROPAGATING ELECTRON PLASMA WAVES IN THE IONOSPHERE. Arnush, D. (TRW Systems Group, Redondo Beach, California 90278); Fried, B.D.; Kennel, C.F. J. Geophys. Res. 79: No. 13, 1885-1894 (1 May 1974).

We compute the linear parametric convective amplification of electron plasma waves by an O mode pump propagating vertically into a vertically stratified ionosphere. The upshifted plasma line compares favorably with Arecibo observations, center frequency, spectral width, and possibly amplitude when the radar is aimed in a northerly direction. The dependence of the computed enhanced plasma line shape upon density scale length, electron-to-ion temperature ratio, pump power, density gradient scale length, and backscatter radar incidence angle is investigated. (auth)

13625 PROTON PRECIPITATION AND THE Hβ EMISSION IN A POSTBREAKUP AURORAL GLOW. Söraas, F.; Lindalen, H.R. (Department of Physics, University of Bergen, Bergen, Norway); Måseide, K.; Egeland, A.; Sten, T.A.; Evans, D.S. J. Geophys. Res. 79: No. 13, 1851-1860 (1 May 1974).

Measurements of the hydrogen auroral emissions have been made by rocket-borne photometers simultaneously with observations of the energy spectra and pitch angle distributions of the precipitating energetic particles. The rocket was flown through a postbreakup auroral glow known to be associated with proton precipitation on the basis of optical measurements from the ground. The observed Hβ profiles are compared with the profiles derived from the measured primary proton beam and obtained by using Eather's (1967) values for the pertinent excitation cross sections. Good agreement between measured and computed profiles is obtained. The measured height profiles had the same shape during the ascent and descent parts of the flight, although the intensity of the Hβ emission varied by a factor of 2. The maximum volume emission rate was found to be at 112±1 km in both cases, whereas the half value emission rates were at 107 and 119 km. The atmospheric density above 120-km altitude had to be reduced by a factor of 2 in comparison with the Cira (1965) model atmosphere in order to account for the observed energy degradation of the incoming proton beam. (auth)

Magnetospheric Phenomena

Refer also to abstract 13536.

13626 INVESTIGATION INTO THE GEOCORONAL AND INTERPLANETARY HYDROGEN BALMER EMISSIONS. Atreya, S. K. Ann Arbor, MI; Univ. of Michigan (1973). 209p. University Microfilms Order No. 74-3572.

Thesis (Ph. D.).

The nighttime emission of the terrestrial hydrogen Hα line results from the radiation transport of the solar Lβ to the darkened hemisphere of the Earth by multiple scattering on the atomic hydrogen of the geocorona. The volume emission rate of this line peaks quite high in the exosphere. Therefore, the temperature retrieved from the Doppler profile of such radiation should indicate the true exospheric temperature. A straightforward determination of the Doppler profile of the geocoronal Hα line is, however, hampered by the possible presence of extraterrestrial sources of Hα emission such as interplanetary, galactic, and discrete stellar sources, or even zodiacal light and gegenschein. In this study, the focus was on the Doppler profile measurement of the geocoronal Hα line. In addition, the most controversial of the extraterrestrial sources, the interplanetary hydrogen was also investigated theoretically to predict its Balmer emission rates and Doppler profiles. (WDM)

13627 A MODEL OF THE OPEN MAGNETOSPHERE. Kan, J.R.; Akasofu, S. (Geophysical Institute, University of Alaska, Fairbanks, Alaska 99701). J. Geophys. Res. 79: No. 10, 1379-1384 (1 Apr 1974).

The Chapman-Ferraro image method is extended to construct an idealized model of the open magnetosphere that responds to a change of the interplanetary field direction as well as to a change of the field magnitude or of the solar wind momentum flux. The magnetopause of the present model is an infinite plane surface having a normal field component distribution that is consistent with the merging theory. An upper limit on the inward displacement of the magnetopause following a southward turning of the interplanetary field is obtained. The results are in fair agreement with a single event reported by Aubry et al. (1971). The model determines the field configuration and the total magnetic flux connecting the magnetosphere to interplanetary space. (auth)

13628 PARTICLE PRECIPITATION AND RADIATION BELT IN LABORATORY EXPERIMENTS. Dubinin, E.M.; Podgorny, I.M. (Institute of Space Research, USSR Academy of Sciences, Moscow, USSR). J. Geophys. Res. 79: No. 10, 1426-1431 (1 Apr 1974).

Precipitation of particles and how they intrude into the magnetosphere have been investigated in a laboratory experiment. An artificial magnetosphere with a geomagnetic tail has been generated as a result of plasma flow interaction with the field of a magnetic dipole. Two precipitation zones at different latitudes are distinctly observed on the dayside. High-latitude precipitation is associated with plasma intrusion into a polar gap. A low-latitude zone embraces the terrella. Its origin is associated with a radiation belt. Radiation belt filling with particles takes place on the nightside as a result of the convection of force lines into the magnetosphere. It is shown that an equatorial gap originating at the dayside transforms into the plasma sheet in the magnetosphere tail. (auth)

13629 MOTION OF MAGNETOSPHERIC PARTICLE CLOUDS IN A TIME-DEPENDENT ELECTRIC FIELD MODEL. Roederer, J.G. (Department of Physics and Astronomy, University of Denver, Denver, Colorado 80210); Hones, E.W. Jr. J. Geophys. Res. 79: No. 10, 1432-1438 (1 Apr 1974).

A computer code has been developed to study quantitatively the drift

motion of magnetospheric particles in a time-dependent electric field. These calculations were applied to the case of proton and electron injections from the plasma sheet during substorms; the model predictions were checked against observations on board the geosynchronous satellite ATS 5 by DeForest and McIlwain (1971). It was found that it is possible to stimulate the observed proton spectrograms with an adequate choice of a time-dependent electric field model. The resulting kinematics is physically quite simple and in its gross features does not depend too strongly on the particular fine structure of the model. To fit the observations reasonably well, the principal requirements for the time-dependent components of the model are (1) a spatial structure that consists of an overall dawn-dusk component of the electric field and an azimuthal (dawn-dusk directed) field sharply localized near the midnight meridian and (2) a time dependence, identical for both spatial structures, that consists of a fast rise (lasting about 10 min) and a slow decay (lasting about 2 hours). Protons injected from the plasma sheet can follow three possible kinds of trajectories: (1) westward drift and convection to the day side magnetopause, (2) westward drift and capture into a trapped mode, and (3) eastward drift from the plasma and convection to the morning side magnetopause. Electrons of $\geq$10keV at the synchronous orbit move only eastward and do not appear in a trapped mode. All major features of the proton clouds seen in the ATS 5 spectrograms can be explained quantitatively with this model. In these calculations, only 90° pitch angle particles of $\geq$10keV (at the synchronous orbit) were considered. (auth)

13630 STUDY OF A SMALL MAGNETOSPHERIC SUBSTORM. Johnstone, A.D. (Mullard Space Science Laboratory, Holmbury St. Mary, Surrey, England); Boyd, J.S.; Davis, T.N. J. Geophys. Res. 79: No. 10, 1403-1415 (1 Apr 1974).

Data from a rocket launched into the expansion phase of an auroral substorm have been compared with data from numerous ground stations and several space vehicles. It is shown that this magnetic and auroral substorm has most of the features of larger substorms; thus it is implied that the same plasma processes are involved in all substorms. Some evidence is presented to link the auroral breakup with the field lines conjugate to the inner edge of the plasma sheet. The implications of these two results for substorm morphology and the triggering mechanism of the substorm instability are discussed. It is concluded that spatial gradients in plasma temperature are a likely cause. (auth)

13631 WHISTLER WAVES OBSERVED UPSTREAM FROM COLLISIONLESS SHOCKS. Fairfield, D.H. (Laboratory for Extraterrestrial Physics, Goddard Space Flight Center, Greenbelt, Maryland 20771). J. Geophys. Res. 79: No. 10, 1368-1378 (1 Apr 1974).

Waves in the frequency range 0.5–4. Hz have been studied in the region upstream of the earth's bow shock with data from the flux-gate magnetic field experiment on Imp 6. Such waves are invariably detected adjacent to the shock, persisting upstream for intervals often less than a minute but occasionally of the order of many hours. Analysis of 150 examples of these waves ($\Delta B/B \simeq 0.2$) during a 3-month interval indicates that propagation directions generally make angles of between 20° and 40° with the field direction. The waves as measured in the spacecraft frame of reference are either left- or right-hand-polarized with respect to the average field direction. The left-handed waves generally have lower frequencies than the right-handed waves, and the left-handed frequencies never exceed 2.5 Hz. The measured sense of polarization is found to depend on the propagation direction (or alternatively, the field direction) relative to the solar wind direction. Propagation-solar wind angles greater than approximately 40° (or field angles greater than 55°) correspond to right-hand polarization, and smaller angles correspond to left-hand polarization. It is concluded that the observed waves are right-handed waves in the plasma frame of reference with wavelengths of approximately 100 km propagating upstream in the whistler mode. Doppler-shifting reduces the observed frequencies in the spacecraft frame and reverses the observed polarization for those waves propagating more directly upstream. Similar waves are seen ahead of some interplanetary shocks. (auth)

13632 PROLONGED TAILWARD FLOW OF PLASMA IN THE THINNED PLASMA SHEET OBSERVED AT $R \approx 18R_E$ DURING SUBSTORMS. Hones, E.W. Jr. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87544); Lui, A.T.Y.; Bame, S.J.; Singer, S. J. Geophys. Res. 79: No. 10, 1385-1392 (1 Apr 1974).

Measurements of plasma and energetic electrons made during substorms of Vela satellites within $\lesssim 1\ R_E$ of the magneto tail neutal sheet are reported. Rapid antisunward flow of plasma is observed to start at the onset of the expansion of phase of a substorm (i.e., at breakup) and to continue until the expansion phase ends and substorm recovery begins as is indicated by auroral zone magnetograms. When substorm recovery begins, the plasma flow reverses direction, and rapid sunward flow begins. Fluxes of energetic electrons are low, and the temperature of the plasma is reduced during the interval of antisunward flow. The lowest fluxes (i.e., complete dropouts) of energetic electrons are observed just before the reversal of plasma flow to the sunward direction. After the reversal the energetic electron flux intensity rises rapidly to high values as the plasma sheet recovers. These observations are regarded as added evidence that a neutral line forms between the earth and the Vela orbit ($r \simeq 18R_E$) at substorm breakup and then moves suddenly to distances beyond the Vela orbit when substorm recovery starts. Throughout the expansive phase there exists a thin residual plasma sheet beyond the neutral line in which plasma continually flows rapidly downstrean into the more distant tail. The particle dropout just preceding the flow reversal and plasma sheet recovery is thought to be the signature of the passage of the neutral line near the Vela satellite as it moves rapidly outward in the tail. Spin modulation of the proton flux observed continuously for about 1 hour during very quiet conditions preceding one substorm may constitute a direct measurement of the proton component of the cross-tail electric current that maintains the taillike configuration of the magnetotail field. (auth)

13633 VARIATIONS OF THE TRAPPED PARTICLE POPULATION AND OF CUTOFF AND PITCH ANGLE DISTRIBUTION OF SIMULTANEOUSLY OBSERVED MAGNETOSPHERIC SOLAR PROTONS DURING SUBSTORM ACTIVITY. Häusler, B. (Space Sciences Laboratory, University of California, Berkeley, California 94720); Scholer, M.; Hovestadt, D. J. Geophys. Res. 79: No. 13, 1819-1824 (1 May 1974).

The behavior of solar protons (1.5–2.7 MeV) and trapped electrons (>1.5 MeV) observed by a low-altitude polar-orbiting satellite (Azur) during the occurrence of an isolated substorm (March 29–30, 1970) is examined. Onset of the substorm is determined and its development is discussed by using energetic and high-energy particle data from the ATS 5 satellite. The comparison of equatorial and low-altitude electron data shows that the behavior of the trapped electron population is consistent with the adiabatic model given by Lezniak and Winckler (1970). Observation of an isotropic pitch angle distribution of the solar protons leads to the conclusion that there is evidence for strong pitch angle scattering of these particles in the pseudotrapping region. We also observed during the substorm a large change in the slope of the particle flux profile at cutoff that occurred simultaneously with a variation of the trapping boundary. It is suggested that this effect might explain the often observed 'deep entry' of solar protons into closed drifts shells well below the nominal cutoff. (auth)

13634 DRIFTING ENERGETIC PARTICLE BUNCHES OBSERVED ON ATS 5. Bogott, F.H. (Space Sciences Laboratory, University of California, Berkeley, California 94720); Mozer, F.S. J. Geophys. Res. 79: No. 13, 1825-1830 (1 May 1974).

Energetic protons and electrons introduced into the vicinity of the synchronous orbit by geomagnetic substorms and observed on ATS 5 at various local times have been analyzed for velocity dispersion effects associated with their longitudinal drift. Particles with energies between about 30 and 200 keV are shown to be produced simultaneously within tens of minutes at local times between about 0000 and 0400 near 6.6 R_E during substorm activity. Those with energies $\gtrsim$ 75 keV move in longitude in the direction and with the magnitude expected from gradient B drifts. Lower-energy protons and electrons appear at the satellite sooner than expected from their gradient B drifts, as though the observed particles of such energies were not those originally accelerated but were newly produced from or by the higher-energy drifting component. (auth)

13635 MAGNETOTAIL VARIATIONS ASSOCIATED WITH THE SOUTHWARD INTERPLANETARY MAGNETIC FIELD. Meng, C. (Space Sciences Laboratory, University of California, Berkeley, California 94720); Colburn, D.S. J. Geophys. Res. 79: No. 13, 1831-1835 (1 May 1974).

Ten weeks of simultaneous fine time resolution data of the interplanetary magnetic field (IMF), the solar wind parameters observed by the Explorer 33 and Vela 3 satellites, the magnetic field, and the particle fluxes in the magnetotail from the Imp 3 satellite are examined together with auroral zone magnetograms monitoring substorm activity to study the magnetotail variations associated with the latitudinal changes of the IMF. It is found that the magnetotail magnetic field magnitude often increases when the B_z component of the IMF is southward; this increment is generally observed throughout the entire high-latitude tail (outside the plasma sheet) from $X \simeq -5R_E$ to $X \simeq -40R_E$. The increment is about 10% of the background field, and it increases to 20% or higher when the B_z component of the IMF increases from the usual 2 or 3γ to 7 or 8γ. (auth)

13636 GENERATION OF ALFVÉN WAVES IN THE MAGNETOSPHERE BY PARAMETRIC INTERACTION BETWEEN WHISTLERS. Harker, K.J.; Crawford, F.W. (Institute for Plasma Research, Stanford University, Stanford, California 94305); Fraser-Smith, A.C. J. Geophys. Res. 79: No. 13, 1836-1843 (1 May 1974).

A theory is developed for the generation of Alfvén waves by the mixing of whistler waves. Calculations are carried out for interaction in the magnetsphere where the whistlers fall in the VLF frequency range and the Alfvén wave falls in the ULF (1–5 Hz) range. Typical amplitudes of 2–5 my for the Alfvén wave are calculated, and it is shown that these values might be increased by 1 order of magnitude

through suitable variation of the experimental parameters. The study thereby develops a possible explanation for naturally occurring Pc 1 micropulsations and demonstrates the feasibility of artificial generation of such micropulsations by ground-launched whistlers. (auth)

13637 ENERGETIC O^+ IONS IN THE MAGNETOSPHERE. Sharp, R.D.; Johnson, R.G.; Shelley, E.G.; Harris, K.K. (Lockheed Palo Alto Research Laboratory, Lockheed Missiles and Space Company, Inc., Palo Alto, California 94304). J. Geophys. Res. 79: No. 13, 1844-1850 (1 May 1974).

Observations of energetic heavy ions are reported on seven occasions during three magnetic storms in 1969. The data were acquired from an energetic ion mass spectrometer experiment on satellite 1969-25B. Measurements were made at 1.3 and 9 keV. Data from an orbit on March 24, 1969, are examined in some detail. The observed heavy ion fluxes are shown to exhibit a morphology similar to that reported by Shelley et al. [1972] for O^+ fluxes in the magnetic storm of December 17, 1971, and their identification as O^+ ions is made on this basis. The latitude distribution of these ion fluxes is compared to simultaneous satellite and ground-based measurements of other phenomena. In the case examined, the most intense O^+ fluxes were found to be located equatorward of the high-latitude boundary of locally mirroring energetic electrons and poleward of a stable auroral red (SAR) arc. They were located on a steep density gradient in the ambient cold plasma at the satellite altitude of 480 km. A comparison of the location of the O^+ fluxes on six other occasions with SAR arc observations acquired during the same storms indicates that the low-latitude limit of the $O^+$is on the average about 1 L unit poleward of the arc. (auth)

13638 DETACHED PLASMA REGIONS IN THE MAGNETOSPHERE. Chappell, C.R. (Department of Applied Physics and Information Science, University of California, San Diego, La Jolla, California 92037). J. Geophys. Res. 79: No. 13, 1861-1870 (1 May 1974).

Regions of high-density cold plasma have been observed outside the plasmasphere in the plasma trough region of the magnetosphere. These detached plasma regions may have densities as high as several hundred ions per cubic centimeter in the normally low-density ($\sim$1 ion/cm^3) plasma trough. The detached plasma regions are found across the day side of the magnetosphere, particular concentrations being in the afternoon-dusk sector. The regions are located at the plasmapause at dusk and progressively farther away for earlier local times in the early afternoon and morning. Detached plasma regions are observed during moderate to disturbed magnetic activity conditions. They exhibit a very complex spatial structure with sizes varying from thousands of kilometers down to less than 50 km in extent. The detached regions may be generated by variations in the magnetospheric convection electric field, which occurs during substorm activity. (auth)

13639 THE BEHAVIOR OF THE PLASMAPAUSE AT MID-LATITUDES: ISIS 1 LANGMUIR PROBE MEASUREMENTS. Brace, L.H.; Theis, R.F. (Goddard Space Flight Center, Greenbelt, Maryland 20771). J. Geophys. Res. 79: No. 13, 1871-1884 (1 May 1974).

Observations of the electron concentration N_e and the temperature T_e from the electrostatic probes on the Isis I satellite were used to examine the location and behavior of the plasmapause at about 3000-km altitude in the vicinity of L=4. At these altitudes the N_e measurements are equivalent to measurements of H^+, since the satellite is well into the protonosphere. The plasmapause is evident as a sharp drop in N_e by a factor of 100 as the satellite passes into the polar cap, and a corresponding increase is observed as it enters the plasmasphere on the opposite side of the earth. An enhancement of T_e is also observed at the plasmapause, an effect that is most visible at night, when the temperatures at latitudes above and below the plasmapause are usually very low. The position of the plasmapause decreases with magnetic activity but is found to be somewhat less sensitive to Kp than is the equatorial plasmapause. Also, unlike its equatorial behavior, the mid-latitude plasmapause behavior exhibits no detectable late afternoon bulge. These differences imply rather complex coupling of the thermal plasma along the field lines that link these two regions of plasmasphere. An additional factor may be the recently observed axial asymmetry in the geomagnetic field at high altitudes. (auth)

13640 MICROPULSATION PERIODS AND THE SIZE OF THE MAGNETOSPHERE. Patel, V.L. (Department of Physics and Astronomy, University of Denver, Colorado 80210). J. Geophys. Res. 79: No. 13, 1974-1976 (1 May 1974).

Three principal methods have been used in the study of geomagnetic micropulsation periods and the magnetospheric parameters. The plasma data of Venera 2,4,5, and 6 and Imp 1 show that the period T is correlated with the interplanetary plasma flux and more closely with the plasma density. (AIP)

13641 SIMULATION EXPERIMENT OF THE CURRENT DISSIPATION AND PLASMA ACCELERATION IN THE NEUTRAL SHEET. Ohyabu, N.; Okamura, S.; Kawashima, N. (Institute of Space and Aeronautical Science, University of Tokyo, Komaba, Meguro-ku, Tokyo). J. Geophys. Res. 79: No. 13, 1977-1980 (1 May 1974).

The dissipation of the magnetic field energy into particle energies at a magnetic neutral point has been studied extensively in connection with the mechanism of the solar flares and the dynamics of the neutral sheet behind the earth, and it is considered that the magnetic energy is dissipated into particle energies in either a quasi-steady or nonsteady neutral sheet. (AIP)

13642 PLASMA SHEET AT LUNAR DISTANCE DURING MAGNETOSPHERIC SUBSTORMS. Rich, F.J. (Benet Weapons Laboratory, Watervliet Arsenal, Watervliet, New York 12189); Reasoner, D.L.; Burke, W.J.; Hones, E.W., Jr. J. Geophys. Res. 79: No. 13, 1981-1984 (1 May 1974).

Evidence is described from the charged particle lunar environment experiment (CPLEE) to support the thesis that the plasma sheet thins at the onset of a substorm and expands during substorm recovery in the region $-60R_e \leq X_{sl} \leq -15R_e$. A comparison of substorm data from Vela 6A and CPLEE suggests that thinning does not occur simultaneously throughout the region but propagates as a 'thinning' wave as plasma is ejected from the near-earth region of the tail. (auth)

13643 A RELATION BETWEEN ELF HISS AMPLITUDE AND PLASMA DENSITY IN THE OUTER PLASMASPHERE. Chan, K.; Holzer, R.E. (University of California, Institute of Geophysics and Planetary Physics, Los Angeles, California 90024); Smith, E.J. J. Geophys. Res. 79: No. 13, 1989-1993 (1 May 1974).

Simultaneous observations of ELF hiss amplitude A and plasma density N on Ogo 5 have been investigated. Passes through the region of variable plasma density in the outer plasmasphere have yielded the quantitative relation $\ln (N/N_0) = K_e A$, where K_e is a constant approximately equal to $10^3\gamma^{-1}Hz^{1/2}$ and N_0 is the plasma density corresponding to the threshold of wave detection. It is suggested that this dependence of wave amplitude on plasma density is a source effect and is related to the wave-particle interaction in the outer plasmasphere that gives rise to hiss. (auth)

13644 CURRENT FLOW IN THE MAGNETOSPHERE DURING MAGNETOSPHERIC SUBSTORMS. Rostoker, G. (Institute of Earth and Planetary Physics, University of Alberta, Edmonton, Alberta, Canada). J. Geophys. Res. 79: No. 13, 1994-1998 (1 May 1974).

A new model current system describing changes in real current flow in the magnetosphere associated with magnetospheric substorm activity is presented in this report. The physically new concept on which this current system is based is the lack of downflowing current in the night side magnetosphere during substorm expansion phase activity. The perturbation pattern stemming from the change in geometry of this new current system configuration can be calculated precisely by using the equivalent three-dimensional current loop discussed by Bonnevier et al. (1970). (auth)

PHYSICS (ATOMIC AND MOLECULAR)

13645 SURFACE AND VACUUM PHYSICS INDEX. Thesaurus, 1974. Leopoldshafen, Ger.; Zentralstelle fuer Atomkernenergie-Dokumentation (1974). 19p.

13646 SURFACE AND VACUUM PHYSICS INDEX. Volume 9, No. 1, 1974. Bibliography, Author Index, Subject Index in Alphabetical Order, Cumulative Subject Index in Logical Order. Leopoldshafen, Ger.; Zentralstelle fuer Atomkernenergie-Dokumentation (1974). 49p.

13647 SURFACE AND VACUUM PHYSICS INDEX. Volume 9, No. 2, 1974. Bibliography, Author Index, Subject Index in Alphabetical Order, Cumulative Subject Index in Logical Order. Leopoldshafen, Ger.; Zentralstelle fuer Atomkernenergie-Dokumentation (1974). 43p.

13648 SURFACE AND VACUUM PHYSICS INDEX. Volume 9, No. 3, 1974. Bibliography, Author Index, Subject Index in Alphabetical Order, Cumulative Subject Index in Logical Order. Leopoldshafen, Ger.; Zentralstelle fuer Atomkernenergie-Dokumentation (1974). 56p.

13649 SURFACE AND VACUUM PHYSICS INDEX. Volume 9, No. 4, 1974. Bibliography, Author Index, Subject Index in Alphabetical Order, Cumulative Subject Index in Logical Order. Leopoldshafen, Ger.; Zentralstelle fuer Atomkernenergie-Dokumentation (1974). 53p.

Beams and Their Reactions

Refer also to abstracts 12814, 14158, and 14375.

13650 (SLA-74-5034) ENERGY DISTRIBUTIONS OF IONS FROM A PULSED VACUUM ARC. Grissom, J. T. (Sandia Labs., Albuquerque, N. Mex. (USA)). 1974. 6p. (CONF-740716-2). Dep. NTIS $4.00.

From sixth international symposium on discharges and electrical insulation in vacuum; Swansea, UK (15 Jul 1974).

Single-shot measurements of the complete energy distributions of mass-selected ions from a 6-μsec vacuum arc discharge were performed using a time-of-flight (TOF) mass spectrometer. The energy distributions of ions mass-separated according to flight times in a two-meter drift tube were obtained by observing the spreading in time of individual 15-nsec ion bursts produced by the TOF spectrometer deflection plate assembly. Energy distributions of ions identified as Al^{+1}, Al^{+2}, Al^{+3}, O^{+1}, O^{+2}, Cr^{+2}, Cr^{+3} and Ni^{+3} or Co^{+3} were measured. (auth)

13651 RELAXATION RATES FROM TIME OF FLIGHT ANALYSIS OF MOLECULAR BEAMS. Gallagher, R.J.; Fenn, J.B. (Department of Engineering and Applied Science, Yale University, New Haven, Connecticut 06520). J. Chem. Phys. 60: No. 9, 3487-3491 (1 May 1974).

In the free jet generated when a gas is expanded from a reservoir at stagnation temperature T_0 and pressure P_0 into a vacuum chamber, substantial lags can occur in the conversion of internal energy into directed kinetic energy of the expansion. An analytical technique is presented for determining rotational energy relaxation rates from velocity distributions measured on the axis of the free jet at a fixed distance from the sonic throat. The agreement with rates obtained by other methods is good. Some sample experimental and analytical results for carbon dioxide, oxygen, hydrogen, and methane are presented. (auth)

13652 MEASUREMENT OF SPIRALING IN A MAGNETICALLY CONFINED ELECTRON BEAM FOR USE IN COLLISION STUDIES. Taylor, P.O.; Dolder, K.T.; Kauppila, W.E.; Dunn, G.H. (Joint Institute for Laboratory Astrophysics, National Bureau of Standards and University of Colorado, Boulder, Colorado 80302). Rev. Sci. Instrum. 45: No. 4, 538-544 (Apr 1974).

A method is described to directly measure mean spiral diameter in a magnetically confined electron beam. In collision experiments, spiraling affects polarization measurements and effective path length assessment; and in experiments using colliding beams, the collision energy or energy spread can be significantly altered. The technique described here allows experimental correction for these effects. Magnitudes of transverse velocities from various causes leading to spiraling are estimated on the basis of models. A gun designed for use in crossed beam electron–ion excitation experiments is described, and results of tests on spiraling and space charge effects for this gun are given. The tests generally indicate the modeling to be correct. Judicious choice of operating conditions led to path length corrections as small as $4\pm2\%$ at 3 eV, decreasing to $0.25\pm0.2\%$ at 200 eV. (auth)

13653 A SUPERSONIC MOLECULAR BEAM METASTABLE ATOM SOURCE INITIATED BY DIRECT DISCHARGE. Searcy, J.Q. (Department of Engineering and Applied Science, Yale University, New Haven, Connecticut 06520). Rev. Sci. Instrum. 45: No. 4, 589-590 (Apr 1974).

A novel combination of corona discharge with a sonic nozzle has been explored as a molecular beam source of excited helium atoms. Time-of-flight velocity distributions for the excited species have been determined as a function of discharge current. The device has the advantage of simple construction along with the other desirable characteristics of nozzle sources. (auth)

13654 NANOSECOND PULSED ELECTRON SOURCE WITH DOUBLE PULSE CONTROL. Yamamoto, T.; Takeda, S.; Kawanishi, M. (Radiation Laboratory, The Institute of Scientific and Industrial Research, Osaka University, Suita, Osaka, Japan). Rev. Sci. Instrum. 45: No. 4, 591-592 (Apr 1974).

A nanosecond pulsed electron beam is obtained by controlling the grid of the electron gun with sequential positive and negative pulses. Two mercury-wetted switches are operated to generate the double pulses. The source can deliver a 100 keV pulsed beam of the order of 1 A with 1 nsec time duration. (auth)

13655 SCATTERING INITIATED BY TWO COHERENT BEAMS. Li, M.C. (Department of Physics, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061). Phys. Rev. A 9: No. 4, 1635-1643 (Apr 1974).

A theory, which exhibits the characteristic features of scatterings initiated by two coherent beams, is discussed in the present paper. We show that the imaginary part of the scattering amplitude is an experimentally measurable quantity. To know the imaginary part of the amplitude is quite important for certain aspects of quantum mechanics, for example, the dispersion relation for a fixed momentum transfer. This relation has not yet been experimentally verified. (auth)

13656 VAN DER WAALS FORCES BETWEEN A Cs ATOM OR A CsCl MOLECULE AND METAL OR DIELECTRIC SURFACES. Shih, A. (Surface Chemistry Section, National Bureau of Standards, Washington, D.C. 20234). Phys. Rev. A 9: No. 4, 1507-1514 (Apr 1974).

The interaction potentials between a spherically symmetric atom (Cs) and a highly conducting surface (gold) or a dielectric surface (glass) are investigated by the atomic-beam-deflection technique. The observed beam profile is least-squares fitted to an r^{-3} potential. The derived interaction constant for the gold surface is 0.59 and 0.67 of the values predicted by Bardeen and Mavroyannis, respectively. A glass surface is found to have an interaction constant 0.65 that of gold. The measurements have also been obtained for a polar molecule (CsCl). With a gold surface the observed beam profile is almost identical to that for stainless steel (reported earlier) in spite of their difference in dc conductivity. Further, the observed constant for an insulator (glass surface) is 0.86 that of gold. With gold, the interaction constant obtained for a cesium-halide molecule, with a strong permanent dipole moment, is smaller than that for a Cs atom with zero dipole moment. (auth)

13657 PHENOMENOLOGICAL ^{3}He QUASIPARTICLE SCATTERING AMPLITUDE IN DILUTE SOLUTIONS OF ^{3}He IN SUPERFLUID ^{4}He. Kuenhold, K.A. (Department of Physics, The Ohio State University, Columbus, Ohio 43210); Ebner, C. Phys. Rev. A 9: No. 6, 2724-2832 (June 1974).

From measurements of the spin diffusion, thermal conductivity, and viscosity coefficients in dilute solutions of ^{3}He in superfluid ^{4}He, we have phenomenologically determined the amplitude for ^{3}He–^{3}He quasiparticle scattering. Two different parametrizations of the amplitude have been used; one form depends only on the momentum transferred in the scattering event while the other depends on the initial momenta of the quasiparticles as well. The amplitudes are fitted to measurements at temperatures in both the degenerate Fermi-liquid regime ($T \ll T_F$) and the classical regime ($T \gtrsim 2T_F$), whereas most previously determined amplitudes are valid only in the low-temperature regime. Finally, the possibility that the scattering amplitude is ^{3}He-concentration dependent is investigated by fitting measurements at each concentration independently. This procedure indicates that there is an enhancement of the amplitude at small momentum transfer as the concentration increases. (auth)

13658 MASS-SPECTROMETRIC IDENTIFICATION OF THE PARAMAGNETIC COMPONENT OF A MOLECULAR BEAM. THE FOCUSING OF RADICALS. Tal'rose, V.L.; Kudrov, B.V.; Leipunskii, I.O.; Morozov, I.I.; Larichev, M.N. (Institute of Chemical Physics, Academy of Sciences of the USSR, 117334, Moscow, V-334). J. Chem. Phys. 60: No. 12, 4870-4871 (15 June 1974).

The technique of identification of a paramagnetic component of the molecular beam in an inhomogeneous magnetic field is used for investigation of elementary chemical reactions. The focusing of a halogen atom beam as a function of the magnetic field strength is determined.

A detailed mechanism of reaction $F+CF_3I \rightarrow IF+CF_3$ is proposed. The dependence of the focusing of CF_3 and CH_3 radicals obtained in chemical reactions on the field strength is discussed. (auth)

Atomic and Molecular Properties

Refer also to abstracts 13713, 13724, 13743, 13778, 13781, 13784, and 14326.

13659 ROTATIONAL RELAXATION OF MOLECULAR HYDROGEN. Gallagher, R.J.; Fenn, J.B. (Department of Engineering and Applied Science, Yale University, New Haven, Connecticut 06520). J. Chem. Phys. 60: No. 9, 3492-3499 (1 May 1974).

The rotational relaxation rate in molecular hydrogen has been determined experimentally between 300 and 1900°K by time of flight analysis of molecular beams from supersonic free jets. Over their common temperature range from 295 to 1073°K our results are in reasonable agreement with the ultrasonic measurements of Winter and Hill which show a rotational collision number Z_r between 300 and 400. In terms of momentum transfer collisions Z_r is relatively insensitive to temperature. This observation suggests that rotation–rotation transfers play an important role. (auth)

13660 ADIABATIC VIBRATIONAL MATRIX ELEMENTS OF R FOR HD^+. Bishop, D.M. (Department of Chemistry, University of Ottawa, Ottawa, Canada K1N 6N5). J. Chem. Phys. 60: No. 6, 2360-2364 (15 Mar 1974).

Using an adiabatic potential energy curve for the electronic ground state ($^2\Sigma^+$) of HD^+, we determine vibrational wavefunctions, written as 30-term combinations of Morse eigenfunctions, for various vibrational (v) and rotational (J) quantum numbers. These vibrational wavefunctions are then used to evaluate vibrational matrix elements of the internuclear separation (R) for various v and J values. An alternative calculation, first introduced by Tipping, is also investigated: namely, evaluating the matrix elements in terms of parameters of the initial potential energy curve. It is pointed out that these matrix elements of R make a dominating contribution to the dipole transition moments of HD^+. (auth)

13661 FLOATING ELLIPSOIDAL GAUSSIAN ORBITAL COMPUTATIONS ON SMALL MOLECULES. Simons, G.; Schwartz, A.K. (Department of Chemistry, Wichita State University, Wichita, Kansas 67208). J. Chem. Phys. 60: No. 6, 2272-2274 (15 Mar 1974).

Electronic structure calculations on H_2, HeH^+, He_2^{2+}, HeH^-, LiH, BeH^+, Li_2, BH, CH^+, HBH^+, HBeH, $HLiH^-$, $LiHLi^+$, HBH^-, HCH, and HNH^+ are performed using the floating ellipsoidal Gaussian orbital (FEGO) method and optimizing geometries. The resulting electronic energies; nuclear geometries; and shapes, sizes, and locations of orbitals are compared to the corresponding floating spherical Gaussian orbital values. The results suggest that energetics and bond angles are more accurately described by the FEGO computations. Bond lengths are predicted to be longer in the FEGO method. A discussion of the role of lone pair electrons in both methods is given. (auth)

13662 THREE-BODY COULOMB SYSTEMS USING GENERALIZED ANGULAR-MOMENTUM S STATES. Whitten, R.C.; Sims, J.S. (Space Science Division, Ames Research Center, National Aeronauties and Space Administration, Moffett Field, California 94035). Phys. Rev. A 9: No. 4, 1586-1591 (Apr 1974).

An expansion of the three-body Coulomb potential in generalized angular-momentum eigenfunctions developed earlier by one of the authors is used to compute energy eigenvalues and eigenfunctions of bound S states of three-body Coulomb systems. The results for He, H, $e e^+ e$, and $p\mu p$ are compared with the results of other computational approaches. (auth)

13663 DIRAC-HARTREE-FOCK CALCULATION OF THE $2\,^3S_1 \rightarrow 1\,^1S_0$ TRANSITION RATES FOR THE He ISOELECTRONIC SEQUENCE. Johnson, W.R.; Lin, C. (Department of Physics, University of Notre Dame, Notre Dame, Indiana 46556). Phys. Rev. A 9: No. 4, 1486-1493 (Apr 1974).

A new calculation of the M1 decay rates of the metastable $2\,^3S_1$ states of two-electron ions is presented. The calculation is based on the Furry bound-interaction representation of quantum electrodynamics and expansion in powers of αZ is avoided. The basic one-electron states are constructed from solutions to the Dirac equation including the ground-state Dirac-Hartree-Fock potential. Correlation and transverse-photon-exchange effects, both of relative order Z^{-1}, are included in the calculation by the perturbation expansion of the S matrix in powers of α. Decay rates calculated to lowest order in powers of α are smaller than previously reported rates. When correlation and transverse-photon-exchange corrections are included in the calculation, the resulting rates agree well with previous calculations. We estimate that the present values are more accurate than the older results for $Z > 12$, while for smaller Z the older results are expected to be better. The close agreement between the present calculations and previous theoretical results confirms the smallness of both higher-order relativistic effects and of higher-order correlation corrections in calculations of this type. (auth)

13664 MEASUREMENT OF THE HYDROGEN-TRITIUM g_J-FACTOR RATIO. Larson, D.J.; Ramsey, N.F. (Lyman Laboratory of Physics, Harvard University, Cambridge, Massachusetts 02138). Phys. Rev. A 9: No. 4, 1543-1548 (Apr 1974).

A hydrogen maser operating at fields of up to 16 G has been used as a spin-exchange detector of Seeman transitions in the hyperfine spectra of hydrogen and tritium. The maser oscillates on the field-dependent π transition which is sensitive to the state of colliding atoms. Atomic magnetic moment or g_J-factor ratios were obtained from the measured Zeeman frequecies with the aid of the Breit-Rabi formula. Measurements were made at different values of magnetic field and an extrapolation was done to eliminate the effects of spin-exchange frequency shifts. The result is $g_J(H)/g_J(T) = 1+(10.7\pm1.5)\times10^{-9}$ in agreement with the theoretical predictions. (auth)

13665 K-L x-RAY ANGULAR CORRELATIONS IN Cm, Pu, AND Eu. Macias, E.S.; Zalutsky, M.R. (Department of Chemistry, Washington University, St. Louis, Missouri 63130). Phys. Rev. A 9: No. 6, 2356-2364 (June 1974).

Angular correlations between K and L x rays in ^{243}Cm, ^{239}Pu, and ^{153}Eu were measured. The x rays of Cm, Pu, and Eu were obtained from radioactive sources of 352-y ^{249}Cf, 32-y ^{243}Cm, and 242-day ^{153}Gd, respectively. The K x rays were detected with a cooled Ge(Li) spectrometer with energy resolution of 500-eV full width at half-maximum (FWHM) at 122 keV. The L x rays were detected with a cooled Si(Li) spectrometer with energy resolution of 170 eV (FWHM) at 5.9 keV. Several corrections to the angular-correlation coefficients were made including a correction for the presence of silicon x-ray escape peaks. The corrected angular-correlation coefficients are:

Cascade	A_{22}(Cm)	A_{22}(Pu)	A_{22}(Eu)
$K\alpha_1$-Ll	$(26.4\pm2.2)\times10^{-3}$	$(27.0\pm1.7)\times10^{-3}$	$(20.5\pm5.9)\times10^{-3}$
$K\alpha_1$-$L\alpha_{1,2}$	$(4.48\pm0.56)\times10^{-3}$	$(4.74\pm0.40)\times10^{-3}$	$(2.73\pm0.39)\times10^{-3}$
$K\alpha_1$-$L\beta_{2,5,6,7,15}$	$(5.14\pm0.80)\times10^{-3}$	$(3.09\pm0.57)\times10^{-3}$	$(5.7\pm2.0)\times10^{-3}$

The results for the $K\alpha_1$-$L\alpha$ cascades are in good agreement with theoretical predictions. The results for the $K\alpha_1$-$L\beta$ cascade agrees with theory for Eu but deviates significantly from theory of Pu and Cm. The results for the $K\alpha_1$-Ll cascade in all three elements are lower than theoretical predictions. Results of similar studies of other elements are tabulated and compared to theory. For all elements studied, the experimental angular-correlation coefficient agrees with the theoretical value for the $K\alpha_1$-$L\alpha$ cascade, but is lower than the theoretical value for the $K\alpha_1$-Ll cascade. (auth)

13666 ELECTRONIC CONFIGURATION IN THE GROUND STATE OF ATOMIC LAWRENCIUM. Nugent, L.J.; Vander Sluis, K.L. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720 and Transuranium Research Laboratory, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830); Fricke, B.; Mann, J.B. Phys. Rev. A 9: No. 6, 2270-2272 (June 1974).

Self-consistent relativistic Dirac-Hartree-Fock calculations have been made of some low-lying electronic energies for the atoms of all elements in ground-state ds^2 electron configurations. The results indicate that, contrary to some previous estimates, the ground electronic state of atomic Lr could be in either the $5f^{14}6d7s^2$ or the $5f^{14}7p7s^2$ electron configuration. The separation between the lowest-energy level of the $5f^{14}6d7s^2$ configuration and the lowest-energy level of the $5f^{14}7p7s^2$ configuration is estimated to be $(0\pm3)\times10^3$ cm^{-1} for atomic Lr. (auth)

13667 LASER-PRODUCED RARE-EARTH x-RAY SPECTRA. Burkhalter, P.G.; Nagel, D.J.; Whitlock, R.R. (Naval Research Laboratory, Washington, D. C. 20375). Phys. Rev. A 9: No. 6, 2331-2336 (June 1974).

Laser-produced x-ray spectra of Sm, Gd, and Dy were measured in the energy range 800-2300 eV. Atomic self-consistent-field calculations were used to identify the transitions in ions stripped to the M shell for the Gd spectra. This work extends the Ni I isoelectronic sequence to rare-earth elements. (auth)

13668 SYSTEMATICS IN THE RELATIVE ENERGIES OF SOME LOW-LYING ELECTRON CONFIGURATIONS IN THE GASEOUS ATOMS AND FREE IONS OF THE LANTHANIDE AND ACTINIDE SERIES. Vander Sluis, K.L.; Nugent, L.J. (Transuranium Research Laboratory, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). J. Opt. Soc. Am. 64: No. 5, 687-695 (May 1974).

There is a linear characteristic and a common nonlinear characteristic in the energy differences associated with many lanthanide and actinide electronic configurations involving a change of the number of f electrons by one. The differences of energy, $\Delta_q E(q)$, between the lowest energy levels of the two principal electron configurations in the gaseous atoms of the lanthanide and actinide series exemplify these characteristics. By assuming that the common nonlinear characteristic involves only electrostatic and spin-orbit interaction-energy differences between the parent f-electron core configurations, we obtain linearization functions— one for the lanthanide series and one for the actinide series— which

linearize the $\Delta_4E(q)$ data. These same linearization functions are found to be applicable to the energy differences between most electronic configurations involving the same number of f electrons, including the neutral, the singly, the doubly, and the triply ionized gaseous lanthanides and actinides, independent of the nature or number of valence electrons. (auth)

13669 MOLECULAR ORBITALS OF PtF_6 AND E110 F_6 CALCULATED BY THE SELF-CONSISTENT MULTIPLE SCATTERING Xα METHOD. Waber, T.J.; Averill, F.W. (Department of Materials Science, Northwestern University, Evanston, Illinois 60201). J. Chem. Phys. 60: No. 11, 4466-4470 (1 June 1974).

The ground state one-electron energy states of PtF_6 and E110 F_6 were calculated by the self-consistent multiple scattering Xα method. The results for the platinum compound agree well with the experimentally observed ligand field transition in optical spectra. Relativistic effects on the hexafluoride of E110 are discussed, and a more complex spectra may be found. (auth)

13670 H_3^+: GEOMETRY DEPENDENCE OF ELECTRONIC PROPERTIES. Carney, G.D.; Porter, R.N. (Department of Chemistry, State University of New York, Stony Brook, New York 11790). J. Chem. Phys. 60: No. 11, 4251-4264 (1 June 1974).

As the first step to the ab initio calculation of the vibration–rotation spectrum of the H_3^+ ion, we present results of configuration-interaction calculations of the potential-energy surface and the geometry-dependent electric dipole and quadrupole moments for the ground electronic state. Interpolation on the potential-energy surface, required for setting up the Hamiltonian matrix for nuclear motion, is facilitated by use of generalized Morse functions and Fourier analysis. An analysis of the equilibrium geometry and harmonic force constants is based upon the present and previous calculations. We conclude that H_3^+ has its potential minimum in an equilateral geometry with bond distances of 1.65 a.u. and harmonic frequencies $\omega_A = 3471$ cm^{-1} and $\omega_E = 2814$ cm^{-1}. (auth)

13671 ATOMIC N-SHELL COSTER–KRONIG, AUGER, AND RADIATIVE RATES, AND FLUORESCENCE YIELDS FOR $38 \leq Z \leq 103$. McGuire, E.J. (Sandia Laboratories, Albuquerque, New Mexico 87115). Phys. Rev. A 9: No. 5, 1840-1851 (May 1974).

Calculated N-shell Auger and radiative transition rates, yields, and level widths for $38 \leq Z \leq 103$ are reported. To calculate the $N_{6,7}$ transition rates it was necessary to find formal expressions in LS coupling for the Auger transition rate with initial f holes. In so doing it was found that some expressions previously given for Auger transition rates involving initial f holes were in error. The corrected expressions are presented herein. Because there exist no data on N-shell fluorescence yields, all comparisons with experiment are comparisons of level widths obtained in most instances from x-ray linewidth measurements. For $Z \leq 57$ the calculated values are in reasonable agreement with experiment. However, when the 4f shell begins to be filled the calculated N-shell level widths appear to be significantly larger than the experimental level widths. Some of the discrepancy can be attributed to the sensitivity to Auger-electron energy of the (4l) $-(4l^{-1})(4f)$ super Coster–Kronig process. (auth)

13672 PHOTOIONIZATION FROM EXCITED STATES OF HELIUM. Jacobs, V.L. (Theoretical Studies Branch, Laboratory for Space Physics, Goddard Space Flight Center, National Aeronautics and Space Administration, Greenbelt, Maryland 20771). Phys. Rev. A 9: No. 5, 1938-1946 (May 1974).

The cross sections for photoionization from the 2 ^{1}S, 2 ^{3}S, 2 ^{1}P, and 2 ^{3}P excited states of helium are calculated for photoelectron energies below the n = 2 threshold of He^+ using Hylleraas bound-state wave functions and 1s2s2p close-coupling final-state wave functions. The resonant structures associated with the lowest-lying ^{1}S, ^{1}P, ^{3}P, and ^{1}D autoionizing states of helium are found to be characterized by large values of the line-profile parameter q. The cross sections and the photoelectron angular-distribution asymmetry parameters for the P states are calculated for various polarization states of the target atom and the incident photon. Experiments which would lead to the separate determinations of the S- and D-wave partial photoionization cross sections are discussed. (auth)

13673 DISTRIBUTION OF FINAL STATES RESULTING FROM THE AUTOIONIZATION OF THE $^1\Sigma_g(2p\sigma^2{}_u)$ STATES OF H_2 AND D_2. Hazi, A.U. (Department of Chemistry, University of California, Los Angeles, California 90024). J. Chem. Phys. 60: No. 11, 4358-4361 (1 June 1974).

Using a simple classical model, we calculate the distribution of final states resulting from the autoionization of the $^1\Sigma_g(2p\sigma^2{}_u)$ state of $H_2(D_2)$ to the $^2\Sigma_g(1s\sigma_g)$ state of $H^+{}_2(D^+{}_2)$. The population of vibrational levels differs markedly from that predicted by the Franck–Condon principle for direct ionization. The calculated kinetic energy distributions of H^+ and D^+ have maxima at threshold ($E_{kin} = 0$). The probability of forming dissociated products is smaller for D_2 than H_2. (auth)

13674 FULLY QUANTUM STUDY OF VIBRATIONAL ENERGY TRANSFER BETWEEN H_2 AND D_2. Alexander, M.H. (Department of Chemistry, University of Maryland, College Park, Maryland 20742). J. Chem. Phys. 60: No. 11, 4274-4278 (1 June 1974).

We present here the results of a detailed study of the collisional transfer of vibrational energy between H_2 and D_2. Following our work on D_2–D_2 collisions [J. Chem. Phys. 59, 6254 (1973)], we carry out a fully quantum treatment of the collision dynamics, assuming a collinear geometry. We have used one fully ab initio and four different model interaction potentials. For both the 10–01 and 11–02 processes, we find that the transition probabilities are extremely sensitive to the choice of potential surface. Another result is that nearest-atom model potentials yield inelastic probabilities which are too large. We further show that long-range forces play a far less important role in the case of these off-resonant processes than for the D_2–D_2 near-resonant collisions. Also of interest is the result that the calculated V–V transition probabilities are largely insensitive to the choice of a harmonic or Morse oscillator description of the colliding molecules. (auth)

13675 PHASE-SPACE THEORY OF ATOMIC DISSOCIATION AND RECOMBINATION REACTIONS: $H+H+H=H_2+H$. Kung, R.T.V.; Anderson, J.B. (Department of Engineering and Applied Science, Yale University, New Haven, Connecticut 06520). J. Chem. Phys. 60: No. 10, 3731-3743 (15 May 1974).

The modified phase-space theory of reaction rates was coupled with Monte Carlo trajectory calculations to yield rate constants and energy distributions of reactants and products for the three-atom dissociation and recombination reactions of hydrogen at 4000°K. Sample trajectories selected from those crossing a surface in phase space were calculated in forward and reverse directions to determine the classical rates of formation of bound and quasibound molecules from atoms. The probability of stabilization of quasibound molecules in successive collisions with hydrogen atoms was determined from additional trajectory calculations. The steady state correction factor for recombination, which accounts for dissociation of newly formed bound H_2 molecules, was estimated from similar calculations. The computed rate constant for recombination is 3.1×10^{15} cm^6 mole^{-2} sec^{-1}. For equilibrium between free atoms and quasibound molecules established through tunneling, the over-all rate constant is estimated to be 75% higher. In either case the process of termolecular recombination to produce bound molecules makes a substantial contribution to the over-all rate. (auth)

13676 LOCALIZED ORBITALS AND SHORT-RANGE MOLECULAR INTERACTIONS. II. NONADDITIVITY IN He_3 AND He_4. Musso, G.F.; Magnasco, V.; Giardina, M.P. (Istituto di Chimica Industriale dell' Università, 16132 Genova, Italy). J. Chem. Phys. 60: No. 10, 3749-3753 (15 May 1974).

Short-range interatomic interactions in singlet He_3 and He_4 are discussed in terms of a single determinant of doubly occupied nonorthogonal localized orbitals through the formalism described in Paper I [V. Magnasco and G.F. Musso, J. Chem. Phys. 60, 3744 (1974)]. Ab-initio calculations using a minimal set of Slater 1s orbitals are reported for several nuclear configurations. Nonadditive terms can be very well represented as resulting from penetration of pairs of nonorthogonal localized electron groups into the core provided by nuclei and "unperturbed" electrons of all other groups. Even in the small overlap region it is essential to include all the penetration effects, and this is easily done by the present formalism. (auth)

13677 FINE AND HYPERFINE STRUCTURE OF THE 4p AND 5p $^3\Pi_u$ STATES OF H_2. Lombardi, M. (Laboratoire de Spectrométrie Physique, Domaine Universitaire, B.P. 53, Centre de tri-38041 Grenoble-Cedex-France). J. Chem. Phys. 60: No. 10, 4094-4095 (15 May 1974).

Fine and hyperfine constants for the 4p and 5p $^3\Pi_u$ states of H_2 are calculated using programs described in a previous paper [M. Lombardi, J. Chem. Phys. 58, 797 (1973)]. The results are compared with experimental values. (AIP)

13678 REVISED IONIZATION ENERGIES OF THE NEUTRAL ACTINIDES. Sugar, J. (National Bureau of Standards, Washington, D.C. 20234). J. Chem. Phys. 60: No. 10, 4103 (15 May 1974).

New experimental results are used to calculate the ionization energies of the neutral actinides from Cm through No. (AIP)

13679 INTENSITY-DEPENDENT IONIZATION POTENTIALS FOR H AND He IN INTENSE LASER BEAMS. Choi, C.K.; Henneberger, W.C.; Sanders, F.C. (Department of Physics, Southern Illinois University, Carbondale, Illinois 62901). Phys. Rev. A 9: No. 5, 1895-1897 (May 1974).

Intensity-dependent ionization potentials for atomic hydrogen and helium in intense laser beams are computed using a theory published earlier. The transformation that yields intensity-dependent potentials is identical to one proposed by Kramers in 1948. Results are given in terms of a parameter that depends on both intensity and frequency of the incident radiation. (auth)

13680 PHOTOABSORPTION IN THE VICINITY OF 3d ABSORPTION EDGES OF La, La_2O_3, Ce, AND CeO_2. Bonnelle, C.; Karnatak, R.C. (Laboratoire de Chimie Physique "Matière et

Rayonnement", Associé au Centre National de la Recherche Scientifique, Université de Paris VI, 75 Paris Vème, France); Sugar, J. Phys. Rev. A 9: No. 5, 1920-1923 (May 1974).

Observations of photoabsorption in La, La_2O_3, Ce, and CeO_2 in the vicinity of the 3d edges are given. Calculations of relative absorption intensities for Ce are shown to correspond well with the experimental data. (auth)

13681 HIGH-ENERGY DEPENDENCE OF THE MOLECULAR-HYDROGEN PHOTOIONIZATION CROSS SECTION. Cooper, J.W. (National Bureau of Standards, Washington, D.C. 20234). Phys. Rev. A 9: No. 5, 2236-2237 (May 1974).

The photoionization cross section for H_2 per atom has recently been reported to be ~45% larger than the atomic cross section at energies of 5.41 and 8.39 keV. This note relates this observation to the differences in electron density at the nucleus in atomic and molecular hydrogen and points out that the enhancement at high photon energies is unique for molecular hydrogen. (auth)

13682 POLARIZATIONS OF THE BALMER-α AND -β LINES PRODUCED BY DISSOCIATIVE COLLISIONS OF H_2^+ WITH THE RARE GASES. Isler, R.C. (Department of Physics, University of Florida, Gainesville, Florida 32611). Phys. Rev. A 9: No. 5, 1865-1872 (May 1974).

The polarizations of the Balmer-α and -β lines produced by dissociative collisions of H_2^+ have been measured at energies from 0.1 to 10 keV for a helium target and from 0.1 to 3 keV for argon and krypton targets. The Balmer-α line exhibits almost zero polarization in all these experiments. The Balmer-β line, however, has a maximum polarization near 13% for the helium target and lower maxima, 6.0% and 2.5%, for argon and krypton targets. The relationship of these results to selective excitation of the H_2^+ molecule and to the angular distributions of the dissociation products is discussed. (auth)

13683 CALCULATIONS OF THE STARK EFFECT IN THE HYDROGEN ATOM IN WHICH THE O(2,2) × O(2) SYMMETRY IS EMPLOYED. Alliliev, S. P.; Malkin, I. A. (Moscow Physical-Technical Inst.). Zh. Eksp. Teor. Fiz.; 66: No. 4, 1283-1294 (Apr 1974). (In Russian).

The Stark effect in the hydrogen atom is analyzed by the perturbation theory technique. The perturbation matrix elements are calculated by means of the dynamic symmetry group for the hydrogen atom. Summation of perturbation theory series is carried out to the fourth order in the field inclusively. The results are compared with previous calculations. (auth)

13684 SPECTRA OF Dy IV AND Ho III. Hussian, R. Baltimore; Johns Hopkins University (1973). 180p. University Microfilms Order No. 74-10,419.

Thesis (Ph. D.).

The spectrum of triply ionized dyprosium was measured between 1200 and 6000 Å, using a pulsed-spark light source and the 5-meter Czerny-Turner vacuum spectrograph at this laboratory. The analysis of the spectrum has identified four levels of $4f^96s$, ten levels of $4f^96p$, and five levels of $4f^95d$. Lack of measurements below 1200 Å has prevented the identification of any $4f^9$ levels. The analysis of the spectrum of doubly ionized holmium was extended for the ^5I core of $4f^{11}$ to all ten $4f^{10}6s$ levels and 28 out of the 30 $4f^{10}6p$ levels. The analysis of hyperfine structure of p- and s-levels was carried out. Assuming $a_{4f} = .036$ cm^{-1}, the other two hfs constants were determined to be $a_{6s} = 0.660 \pm .004$ cm^{-1}; $a_{6p} = 0.0125 \pm .002$ cm^{-1}. The application of the method to the analysis of hfs of Pr IV provides results which are in good agreement with the previous experimental values of hyperfine levels. (Diss. Abstr. Int., B)

13685 INTEGRAL-TRANSFORM TRIAL FUNCTIONS: A NUMERICAL STUDY OF GENERALIZED SCALING, ITERATED TRANSFORMS, AND THE SCALE SPACE INTEGRATION. Somorjai, R.L. (Centre Européen de Calcul Atomique et Moléculaire, 91 Orsay, France); Grimaldi, F. J. Chem. Phys. 60: No. 12, 4833-4839 (15 June 1974).

Two conceptually important and computationally useful aspects of the integral-transform (IT) approach have been tested on the He sequence. Both generalized scaling and the iteration approach enable one to optimize the shape function; a priori discretization of the IT trial functions by M-point integration rules is computationally expedient; coupled with extrapolation procedures it can alleviate the integration difficulties inherent in the IT approach. By optimizing a mapping (generalized scaling) the initial choice of a shape function becomes less crucial; for discretized IT functions it results in the reduction of the number of simultaneous parameter optimizations. The iteration approach transforms the nonlinear parameter optimization into a multistage process, with its attendant advantages. It also minimizes the importance of the initial choice of the cubature rule (discretization). A judicious blend of mapping and iteration, coupled with a priori discretization and subsequent extrapolation seems to be the way to combine the conceptual advantages of the IT approach with computational feasibility. The IT orbitals were of the form $\phi_l(r) = \int_0^\infty dt\, t^\nu \exp(-qt) \exp(-t^2r^2)$, they were discretized by Gauss-Laguerre-type M-point integration rules, and extrapolation studies indicated that as $M \to \infty$, $\lambda(\infty) \simeq -1.5$ and $E(\infty) \simeq E_{H.F.}$ for He. (auth)

13686 INTERPRETATION OF THE ABSORPTION SPECTRUM OF SINGLE CRYSTAL UCl_4. Hecht, H.G. (Los Alamos Scientific Laboratory of the University of California, Los Alamos, New Mexico 87544); Gruber, J.B. J. Chem. Phys. 60: No. 12, 4872-4879 (15 June 1974).

Temperature-dependent polarized absorption spectra of single crystal UCl_4 have been investigated in the range 4000-25 000 Å. The spectra have been assigned and analyzed using the U^{4+} ion in a field of D_{2d} point group symmetry as a model. An rms deviation of 91 cm^{-1} in the fit to 34 assigned levels was achieved using the following set of parameters: $F_2 = 172.6 \pm 1.8$; $F_4 = 38.79 \pm 1.13$; $F_6 = 2.565 \pm 0.101$; $\zeta = 1666 \pm 11$; $A^0_2\langle r^2\rangle = -291.3 \pm 82.6$; $A^0_4\langle r^4\rangle = -378.4 \pm 30.8$; $A^4_4\langle r^4\rangle = -5940 \pm 195$; $A^0_6\langle r^6\rangle = -141.4 \pm 30.3$; $A^4_6\langle r^6\rangle = 557.6 \pm 184.6$ (all units in cm^{-1}). These optical data are interpreted to show that the ground state belongs to the Γ_4 irreducible representation, with the first excited state being a Γ_5 level at approximately 140 cm^{-1}. The parameters are discussed in terms of the bonding characteristic of the coordinated complex ion. (auth)

13687 L X-RAY EMISSION PROBABILITIES FROM SINGLY AND DOUBLY IONIZED ATOMS. Veluri, V. R. Atlanta; Emory Univ. (1973). 97p. University Microfilms Order No. 74-10,297.

Thesis (Ph. D.).

The average L_1 subshell yield ν_1 at Z = 63 and Z = 83 is determined by observing (gamma ray)-(L x-ray) coincidences in the decay of ^{151}Gd and ^{226}Ra respectively. By analyzing the L_γ x rays in coincidence with 241.9 keV gamma rays in the decay of ^{214}Pb, the L_1 yields, ω_1, f_{12}, and f_{13}, are deduced. In general, the present experimental values are slightly lower than the theoretical predictions. The L_2-L_3x Coster-Kronig transition probability, f_{23}, is measured for five elements in the range $63 \le Z \le 81$ by observing the Kα x rays in coincidence with the Lα x rays. There is a general agreement with the theory and a critical comparison with the existing experimental and theoretical values is presented. The average L x-ray yields of (LL)-vacancy states and (LX)-vacancy states in Pb are measured by observing the L x rays in coincidence with the (K-LL) and the (K-LX) Auger electrons in the electron capture decay of ^{207}Bi. The L x-ray emission from the (LL)-vacancy states is found to be 1.5 times higher than the yields expected on the basis of single vacancy estimates, while the L x-ray emission does not seem to have been altered by the presence of an outer shell vacancy. (Diss. Abstr. Int., B)

13688 THEORETICAL ANALYSIS OF THE VIBRATIONAL STRUCTURE OF THE ELECTRONIC TRANSITIONS INVOLVING A STATE WITH DOUBLE MINIMUM: E,F $^1\Sigma^+_g$ OF H_2. Lin, C.S. (Department of Chemistry, University of Windsor, Windsor, Ontario, Canada N9B 3P4). J. Chem. Phys. 60: No. 12, 4660-4664 (15 June 1974).

It is shown that the convergence problem encountered in the numerical integration of the vibrational Schrödinger equation for an electronic state with a double-minimum potential does not exist in the analytical expansion method. For the B $^1\Sigma^+_u$, C $^1\Pi_u$, and E, F $^1\Sigma^+_g$ states of H_2, the expansion method gives consistently and progressively better energy eigenvalues than the numerical integration method. Franck-Condon factors for the transitions B $^1\Sigma^+_u$ - E,F $^1\Sigma^+_g$ and C $^1\Pi_u$ - E,F $^1\Sigma^+_g$ were computed, and the vibrational structure of the case B $^1\Sigma^+_u$ - E,F $^1\Sigma^+_g$ is discussed in some detail. (auth)

13689 OBSERVATION OF SINGLET-TRIPLET ANTICROSSINGS IN He. Miller, T.A.; Freund, R.S.; Tsai, F.; Cook, T.J.; Zegarski, B.R. (Bell Laboratories, Murray Hill, New Jersey 07974). Phys. Rev. A 9: No. 6, 2474-2484 (June 1974).

Two independent anticrossings have been observed between singlet and triplet levels in the He atom, one between the 7 ^{1}D and 7 ^{3}D states, the other between the 8 ^{1}D and 8 ^{3}D states. The states are excited by electron bombardment. Compensatory changes in the luminosity of the singlet and triplet states are detected as the levels are tuned through the anticrossing points by a magnetic field. The positions of the anticrossings have been analyzed to provide new values for these singlet-triplet separations accurate to ~0.03 GHz. These results show the previous best optical determinations for the separations to be in error by over a GHz. The widths of the anticrossings are analyzed to provide the most direct measures of the spin-orbit coupling constant between a singlet and a triplet state yet obtained for any system. The measured values of these coupling constants are found to be several times larger than their corresponding diagonal value in the 7 ^{3}D and 8 ^{3}D states. (auth)

13690 0(3,1) SYMMETRY OF THE HYDROGEN ATOM. Majumdar, S. D.; Basu, B. (Indian Inst. of Tech., Kharagpur). J. Phys., A (London); 7: No. 7, 787-793 (1 May 1974).

The transformation coefficients connecting the Stark and the

angular momentum states belonging to the positive spectrum of the hydrogen atom are calculated by a group-theoretical method which makes use of the 0(3,1) symmetry of the states and also by a purely analytical method. The results of the two calculations agree except for an undetermined factor not containing the orbital quantum number ι. Complete agreement between the results is achieved by taking the normalization factors for the continuum states to be analytic continuations of those for the bound states. The transformation coefficients turn out to be SU(2) Clebsch–Gordan coefficients $(j_1j_2 : m_1m_2m)$ with complex $j_1j_2m_1m_2$, and physical ι, m. From the general theory the well known expansion of the Coulomb scattering function is obtained by giving the magnetic quantum number m and one of the electric quantum numbers, n_2, the special values, 0 and −1, respectively. (auth)

13691 ELASTIC SCATTERING AND ROTATIONAL EXCITATION OF MOLECULAR HYDROGEN BY LOW ENERGY POSITRONS. Baille, P. (Observatoire de Paris, Meudon, France); Darewych, J. W.; Lodge, J. G. Can. J. Phys.; 52: No. 8, 667-677 (15 Apr 1974).

The adiabatic nuclei approximation is used to study low energy positron collisions with hydrogen molecules. The interaction of the positrons with the hydrogen molecules is represented as a superposition of electrostatic and polarization potentials. Total and differential elastic and momentum transfer cross sections are calculated. The effect of small variations in the potentials, and the convergence of the partial wave expansion are discussed. The annihilation rate of the positrons is calculated with and without incorporating the effect of distortion of the electron cloud by the incoming positrons. Rotational excitation cross sections, both differential and total, are presented. The results are compared, where possible, to recent similar two-center calculations of Hara, and experimental results of Coleman et al. (auth)

13692 ENERGY SPECTRUM OF H^- IN A STRONG MAGNETIC FIELD. Henry, R.J.W.; O'Connell, R.F.; Smith, E.R.; Chanmugam, G.; Rajagopal, A.K. (Department of Physics and Astronomy, Louisiana State University, Baton Rouge, Louisiana 70803). Phys. Rev. D 9: No. 2, 329-331 (15 Jan 1974).

The binding energy of the hydrogen negative ion is calculated by a variational method for magnetic fields in the range 0–3 × 10^9 gauss. (auth)

Positronium, Muonium, and Muonic and Mesic Atoms and Molecules

Refer also to abstracts 13662, 13691, and 13994.

13693 MEASUREMENTS OF x RAYS AND γ RAYS FROM STOPPED KAONS. Wiegand, C.E.; Godfrey, G.L. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). Phys. Rev. A 9: No. 6, 2282-2305 (June 1974).

Intensities have been measured for 346 x-ray lines of kaonic atoms of elements and pure isotopes ranging from Z = 2 through Z = 92. Within experimental accuracy, isotopes of the same elements yielded equal intensities. However, a remarkable variation in intensities versus Z was observed for kaonic transitions believed not to be significantly influenced by nuclear absorption. Fourteen x-ray lines from Σ^--hyperonic atoms of light and medium-Z elements were measured. Also observed were 29 nuclear γ-rav lines that followed kaon capture. (auth)

13694 IMPROVED WAVE FUNCTION FOR POSITRONIUM HYDRIDE. Navin, P.B.; Schrader, D.M. (Department of Chemistry, Marquette University, Milwaukee, Wisconsin 53233); Lebeda, C.F. Phys. Rev. A 9: No. 5, 2248-2251 (May 1974).

An extension of an earlier calculation on positronium hydride (PsH) is presented. In the earlier work, the wave function was expressed as an exponential term, $\exp(-Ar_1-Br_2-Cr_{1p}-Dr_{2p}) +$ $\exp(-Br_1-Ar_2-Dr_{1p}-Cr_{2p})$, times a twelve-term polynomial in the interparticle coordinates: r_1, r_2, r_{1p}, r_{2p}, and r_{12} (the electrons are labeled 1 and 2; the positron is labeled as p). The coefficients in the polynomial were determined by the variational method. In the present work, the number of terms is increased; the coordinate r_p is included in the polynomial; the wave function is tested for the four cusp conditions; and an annihilation rate and the relaxation of the daughter system are calculated. The new binding energy, 0.794 eV, is greater than the earlier result by 0.137 eV. The annihilation rate is found to be 2.22 $nsec^{-1}$, with the 1s state being the most probable daughter-occupation state. The electron–positron, electron–nucleus, nucleus–positron, and electron–electron cusp values are, respectively, −0.4398, −1.065, −0.0102, and 0.1126. The values of the repulsive cusps definitely show that the wave function has not yet converged to the exact function in all regions of three-particle space. A search for a bound excited state of PsH with the same symmetry of the ground state was unsuccessful. (auth)

13695 MUONIC X-RAYS AND EQUIVALENT RADIUS OF NUCLEAR CHARGE DISTRIBUTION. Khan, M. H. Lubbock, TX; Texas Tech Univ. (1973). 128p. University Microfilms Order No. 74-5812.

Thesis (Ph. D.).

In muonic atoms the transition energies are related, inter alia, to the radial shapes of the nuclear charge density distribution. The expression is developed showing the relation of the muonic transition energies to the weighted averages of the functions of the radial coordinate. In particular, the transition energies are related to the generalized radial moments of the nuclear charge distribution. For a particular form of the radial function, the energies are simply related to the usual radial moments of the nuclear charge distribution. Through these relations, the change in the equivalent radius of the nuclear charge distribution and the change in the transition energy are related. The effect of the finite size of the muon on the binding energies is considered. This corresponds to adding a term to the binding potential of the muon-nucleus system such that the strength of the potential is decreased. Since the most penetrating orbit in the case of muonic atoms is the 1s orbit, where the muon spends the maximum fraction of its time inside the nucleus, the contribution of the muon size effect is maximum in the 1s state. The binding energies are reduced and the maximum shift occurs in the 2p → 1s transition. It is found that the muon finite size contribution increases with increasing muon size and atomic number. On the contrary, the change in the nuclear radius due to the muon finite size decreases with increasing atomic number. The energy contribution is increased by a factor of about 20 while the change in the nuclear radius is decreased by a factor of about 1.5 only in going from Z ≃ 20 to Z ≃ 82. The inclusion of the muon size also improves the fit in muonic Pb. The slope of the equivalent radius curve (R_n vs n), where R_n is the equivalent radius and n is not necessarily an integer, deviates from the linear relation as n → 0. The moments of the nuclear charge density, $\langle r^n \rangle$, go to unity as n → 0 while the equivalent radii fluctuate between high and low values depending on the half-density radius parameter c_0, and the surface thickness parameter a. The expectation values $\langle r^{-n} \rangle$ and the corresponding R_{-n} are calculated. The product R_nR_{-n} approaches a limiting value as n → 0. The equivalent radii are calculated for various elements. The values of the equivalent radius are determined for 2p → 1s, 3d → 2p and 4f → 3d transitions in ^{120}Sn, ^{138}Ba, ^{140,142}Ce and ^{206}Pb, using the Fermi function without center depression for analysis. (Diss. Abstr. Int., B)

13696 POSITRON ANNIHILATION STUDIES, INCLUDING THE PRESSURE DEPENDENCE OF POSITRON ANNIHILATION IN TEFLON, SILVER, AND PALLADIUM. Klotz, A. S. Pittsburgh; Carnegie-Mellon Univ. (1974). 189p. University Microfilms Order No. 74-8438.

Thesis (Ph. D.).

Positron annihilation angular correlation spectra were obtained for the neon isoelectronic series (neon-neon configuration). Although the curves exhibited different shapes, they were analyzed in terms of a single parameter, Γ, the full width at half-maximum of the angular correlation spectrum. The onset of covalency was seen to countervail the effect of increasing ionic charge. The sharp peakedness of the sodium fluoride (100) angular correlation spectrum was most unusual, and might be due to the trapping of positrons into a bound state at lattice defects. A (100) single crystal of diamond was investigated and compared with corresponding single crystal data of silicon and germanium. Among the 4–4 semiconductors there appeared to be a linear relation between Γ and the inverse of the lattice parameter. By means of a hexagonal pseudocell model of silicon carbide's various crystalline structures, polycrystalline silicon carbide was shown to agree with this linear trend. Γ was obtained for polycrystalline potassium iodide and solid iodine. The relative broadening in Γ for these two compounds was consistent with Mössabauer isomer shift data as well as known atomic configuration. Cellular model calculations, which were performed for some of the crystalline lattices, roughly described several aspects of the data. Positron annihilation angular correlation spectra and lifetime spectra for Teflon were studied as a function of pressure. With increasing pressure, quenching of the narrow component of the angular correlation spectrum as well as the intermediate- and long-lived components of the lifetime spectrum was observed. Of the three hypotheses proposed to explain the modes of annihilation of positrons in Teflon, only the Tao-Green hypothesis satisfactorily described the observed trends. A study of the variation with pressure of the positron annihilation angular correlation spectrum for palladium gave experimental agreement with both the de Haas-van Alphen data of Vuillemin and Bryant and the relativistic band structure calculation of Das, Koelling, and Mueller. With increasing pressure, the predicted decrease in occupied plane wave-like

electron states and concomitant increase in 4d-like electron states could be correlated with the observed shift of palladium's electron momentum distribution towards higher momentum components. (Diss. Abstr. Int., B)

13697 EFFECTS OF POLYMORPHISM ON POSITRON LIFETIMES IN TRIPALMITIN. Walker, W.W.; Kline, D.C. (Department of Physics, University of Alabama, Tuscaloosa, Alabama 35486). J. Chem. Phys. 60: No. 12, 4990-4993 (15 June 1974).

Positron lifetime parameters have been measured in three polymorphic forms of tripalmitin. Differential scanning calorimetry and x-ray powder diffractometry were used to identify the polymorphic forms. Each form exhibited a characteristic long lifetime τ_2. Values of τ_2 obtained at 22°C were 2.30, 1.44, and 2.23 nsec for the α, β, and β' forms, respectively. Lifetime measurements as a function of temperature were also carried out for the α and β forms. (auth)

13698 ANNIHILATION OF POSITRONS IN GASEOUS AND LIQUID NH_3 AND IN NH_3–Ar AND NH_3–Ne MIXTURES. McNutt, J.D.; Kinnison, W.W.; Ray, A.D. (Department of Physics, The University of Texas at Arlington, Arlington, Texas 76019). J. Chem. Phys. 60: No. 12, 4730-4733 (15 June 1974).

The lifetime spectra of positrons annihilating in gaseous NH_3, in NH_3–Ar and NH_3–Ne gas mixtures, and in liquid NH_3 have been measured as a function of density and temperature. The annihilation rate of slow positrons in NH_3 gas, λ_{NH_3}, has a strong nonlinear dependence on gas density and temperature, indicating a complex positron–ammonia interaction. A Z_{eff}/Z ratio of 1860 was observed for 22.5°C NH_3 gas at 2.4×10^{-4} g/cm³. Above gas densities of about 0.0015 g/cm³ at 22.5°C, λ_{NH_3} is found to be equal to the value measured in liquid NH_3 at 0.607 g/cm³. λ_{NH_3} is additionally found to be independent of the partial density of Ar or Ne in the gas mixtures. $^1Z_{eff}$ for orthopositronium annihilation in NH_3 has a temperature independent value of 0.60 ± 0.03 throughout the gaseous and liquid density range investigated. (auth)

13699 MUON–NEUTRON INTERACTION IN HEAVY MUONIC ATOMS. Budick, B. (Physics Department, New York University, New York, New York 10003). Phys. Rev. A 9: No. 6, 2267-2269 (June 1974).

The interaction of the anomalous magnetic moments of neutrons in a hypothetical neutron halo with the muon-charge distribution in heavy muonic atoms is studied. We find large shifts in the 2p levels of the heaviest atoms. The shifts in the 3d level of Ba and in the 4f level of Pb are too small and of the wrong sign to account for the existing discrepancy in the vacuum-polarization corrections to these levels. (auth)

13700 MECHANISM OF POSITRONIUM REACTIONS WITH PARAMAGNETIC MOLECULES. Aravin, L. G.; Sobolev, B. V.; Shantarovich, V. P. (Inst. of Chemical Physics, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 7: No. 6, 467-470(1973).

Translated from Khim. Vys. Energ.; 7: No. 6, 528-532(1973).

The effect of various parameters on the rate of quenching of Ps is considered, together with the fraction converted and the chemical reactions of positronium with paramagnetic molecules. For a number of stable free radicals the fraction converted depends on the solvent polarity and on delocalization of the spin density of the unpaired electron of the quenching molecule. The maximum known quenching rate of positronium in the liquid phase ($6\cdot10^{11}$ liter/mole · sec) occurs at a viscosity of ~1 cP. (auth)

Collision Phenomena

Refer also to abstracts 12820, 13674, 13682, 13691, 14079, 14333, 14389, and 14737.

13701 (N-74-10662) COLLISION QUENCHING EFFECTS IN NITROGEN AND HELIUM EXCITED BY A 30-keV ELECTRON BEAM. Lillicrap, D. C. (National Aeronautics and Space Administration, Langley Station, Va. (USA). Langley Research Center). Nov 1973. 19p. (NASA-TM-X-2842; L-8017). NTIS $2.75.

The quenching cross section for the O–O first negative band of nitrogen is determined for temperatures between 78 and 300 K. As the temperature increases above 78 K, the quenching reaches a maximum at approximately 140 K and then decreases as 300 K is approached. At temperatures on the order of 5000 K, quenching is reported to increase with temperature and must therefore reach a minimum at some intermediate temperature between 300 and 5000 K. By comparison, quenching of the 5016 A helium line increases continuously over the temperature range 78 to 300 K. (auth) (STAR)

13702 GENERALIZED OSCILLATOR STRENGTHS FOR 7.4 eV EXCITATION OF H_2O AT 300, 400, AND 500 eV KINETIC ENERGY. SINGLET–TRIPLET ENERGY DIFFERENCES. Lassettre, E.N.; Skerbele, A. (Center for Special Studies and the Department of Chemistry, Mellon Institute of Science, Carnegie-Mellon University, Pittsburgh, Pennsylvania 15213). J. Chem. Phys. 60: No. 6, 2464-2469 (15 Mar 1974).

Generalized oscillator strengths f have been determined as a function of scattering angle for the 7.4 eV excitation of H_2O vapor by studying the scattering of electrons with kinetic energies of 300, 400, and 500 eV. Over the angle range studied, 2°–7°, f vs $(\Delta P)^2$ (ΔP the momentum change) lie approximately on a common curve at all three kinetic energies. Extrapolation to zero momentum change gives the value $f_0 = 0.060\pm0.006$ for the limiting oscillator strength. Singlet–triplet energy differences are calculated using the generalized oscillator strengths and a recently developed theory by Lassettre and Dillon. (auth)

13703 QUANTUM MECHANICAL CLOSE COUPLING APPROACH TO MOLECULAR COLLISIONS. j_z–CONSERVING COUPLED STATES APPROXIMATION. McGuire, P.; Kouri, D.J. (Max-Planck-Institut für Strömungsforschung, 34 Göttingen, Germany). J. Chem. Phys. 60: No. 6, 2488-2499 (15 Mar 1974).

New coupled equations describing collisions of an atom and a diatomic molecule are derived in this paper. By utilizing a description of the collision in terms of rotating coordinates, all coupling in the z component of angular momentum is isolated into purely kinematic effects. By neglecting these couplings, one is led to approximate equations for which the j_z component of angular momentum for the molecule is conserved. In addition, the scattering cross sections are formulated by neglecting the effect on the wavefunction of the rotation of the coordinate axes so that in place of Wigner rotation matrices $d^J_{mm'}(\Theta)$ appearing, one deals with simple Legendre polynomials and the orbital angular momentum l^2 is approximated by $l(l+1)\,\hbar^2$. It is noted that the procedure involves no approximations so far as the potential matrix elements are concerned. Furthermore, the number of equations remaining coupled is drastically reduced and a completely quantum mechanical description of the dynamics of both internal states and relative motion is retained. The physical implications of the approximations are examined, and it is seen that the neglect of intermultiplet coupling gives rise to consideration of only transitions where both the orientation and magnitude of the rotor angular momentum change. Further, the neglect of transformation effects on the wavefunction is expected to be least accurate for the inelastic forward scattering and best for backward scattering and the $j=0\to0$ elastic scattering. Finally, the present simplest version of the approximation obviously is not intended for treating processes dependent on m_j transitions, e.g., NMR relaxation in He–H_2. Next the formalism is applied in test calculations to He–H_2 collisions using the Krauss–Mies potential energy surface. Numerical results for elastic and inelastic integral and differential cross sections are compared with exact quantum mechanical close coupling solutions of the standard coupled channel equations. Over the energy range studied (from 0.1 eV up to 0.9 eV), agreement to within a few percent is obtained. Additional coupled states calculations are reported at 1.2 eV and computation times are compared against those required for a full close coupling solution. Calculations for the Roberts He–H_2 surface are also reported to illustrate the independence of the approximations on the strength of the coupling (so long as the inelastic scattering is predominantly in the backward direction). The dramatic savings afforded by the present approach are such as to make possible fully converged calculations at collision energies typically studied in molecular beam experiments. Thus, for elastic and inelastic nonreactive collisions, involving a repulsive-type interaction, the approach makes the a priori quantum mechanical description of the scattering of a diatom by an atom practical. (auth)

13704 ION–DIPOLE SCATTERING IN CLASSICAL PERTURBATION THEORY. Gentry, W.R. (Chemical Dynamics Laboratory, Chemistry Department, University of Minnesota, Minneapolis, Minnesota 55455). J. Chem. Phys. 60: No. 6, 2547-2553 (15 Mar 1974).

The classical theory for scattering of ions by dipolar molecules is derived in the perturbation limit applicable at high translational energy and small scattering angles. In this approximation the differential cross section and the dependence of the rotational excitation energy on kinetic energy, impact parameter, and orientation of the dipole are given by simple analytic expressions, and the orientation-averaged quantities of interest for comparison with experiment are easily calculated. The range of validity for this treatment is explored by comparison of the results with those obtained by a less restricted impact-parameter method and by direct numerical integration of the full classical equations of motion. (auth)

13705 DIFFUSION COEFFICIENT AND INTERACTION POTENTIAL OF THE (H, H_2) SYSTEM. Tang, K.T. (Department of Physics, Pacific Lutheran University, Tacoma, Washington 98447); Wei, P.S.P. J. Chem. Phys. 60: No. 6, 2454-2459 (15 Mar 1974).

Binary diffusion coefficients of atomic and molecular hydrogen are calculated from the collision integrals. The interaction potential between the atom and the molecule used in the present calculation is quite different from the Lennard-Jones, Buckingham, and exponential potentials commonly used in the transport studies. It is generated from a H_3 potential surface in the inner region and joined to the van der Waals attraction in the outer region. The results from various potentials

are compared. The present results, which are larger than those of previous calculations, seem to agree generally with the most recent measurements. (auth)

13706 GENERALIZED OSCILLATOR STRENGTHS THROUGH THE WATER VAPOR SPECTRUM TO 75 eV EXCITATION ENERGY; ELECTRON KINETIC ENERGY 500 eV. Lassettre, E.N. (Center for Special Studies and the Department of Chemistry, Mellon Institute of Science, Carnegie-Mellon University, Pittsburgh, Pennsylvania 15213); White, E.R. J. Chem. Phys. 60: No. 6, 2460-2463 (15 Mar 1974).

Generalized oscillator strengths (GOS) as functions of momentum change are reported for four peaks in the electron impact spectrum of water vapor. Differential generalized oscillator strengths are also reported at seven points in the continuum. Extrapolated (to $\Delta P=0$) oscillator strengths are given at even finer intervals. Most of the experiments were done at about 500 eV kinetic energy, but two transitions were studied at 400 eV kinetic energy to test the Born approximation. (auth)

13707 HIGH-ENERGY APPROXIMATION FOR EXCHANGE SCATTERING AND APPLICATION TO 1 ^{1}S–2 ^{3}S EXCITATION OF He BY ELECTRON IMPACT. Huo, W.M. (Center for Special Studies and Department of Chemistry, Mellon Institute of Science, Carnegie-Mellon University, Pittsburgh, Pennsylvania 15213). J. Chem. Phys. 60: No. 9, 3544-3557 (1 May 1974).

A high energy approximation is derived for the second order term in the T matrix for exchange scattering of electrons by atoms or molecules. A limiting selection rule for exchange scattering at high incident energies is obtained, which states that second-order contributions are important in forward scattering if the initial and final states of the target system have the same orbital term symbol. Calculations on the zero angle differential cross section, approximated by the cross section at zero momentum change, of the 1 ^{1}S–2 ^{3}S excitation in He by electron impact are carried out over an energy range 100–500 eV using the present approximation. Reasonable agreement with the experimental data of Skerbele, Harshbarger, and Lassettre [J. Chem. Phys. 58, 4285 (1973)] is obtained, indicating that second-order contributions are sufficient to account for the differences between Born–Oppenheimer calculations and the experimental data. The present calculation also shows that, for this transition in He, a minimum exists in the zero angle differential cross section vs incident energy curve. The existence of the minimum has been verified experimentally by Klump and Lassettre. (auth)

13708 ELECTRON TRANSFER IN COLLISIONS OF DOUBLY CHARGED RARE GAS IONS AND RARE GAS ATOMS FOR PRIMARY ION ENERGIES BELOW 100 eV. Maier, W.B. II (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87544). J. Chem. Phys. 60: No. 9, 3588-3598 (1 May 1974).

Cross sections for the production of Kr^+, Ne^+, and Kr^{++} in collisions of Kr^{++} with Ne and of Ne^{++} with Kr have measured for primary ion energies E between 0.5 and 100 eV. For $E \gtrsim 10$ eV, the cross sections all vary rather slowly and are between 1 and 8 A^2. As E is decreased below 5–10 eV, the cross sections all increase. The cross section σ_a measured for $Kr^{++}+Ne \rightarrow Kr^+ + \cdots$ is expected to be a reasonably accurate representation of the cross section for $Kr^{++}+Ne \rightarrow Kr^+ + Ne^+$; σ_a has been compared with three theoretical results for this reaction, but the theoretical and experimental results do not agree very well. The implications of the discrepancies between theory and experiment are discussed. σ_a is in good agreement with an earlier measurement of $Kr^{++}+Ne \rightarrow Kr^+ + \cdots$ at higher E. The efficiency with which product ions are collected by the present apparatus is discussed. (auth)

13709 ELECTRONIC STATES OF B^+ PRODUCED BY ELECTRON BOMBARDMENT OF BORON TRIHALIDES: SOME ION-MOLECULE REACTIONS OF B^+. Lin, K-C.; Cotter, R.J.; Koski, W. S. (Department of Chemistry, The Johns Hopkins University, Baltimore, Maryland 21218). J. Chem. Phys. 60: No. 9, 3412-3416(1 May 1974).

Beam attenuation studies of B^+ as a function of attenuating gas pressure show that the beam has a composition of 35% ^{3}P and 65% ^{1}S when produced by 70 eV electrons from BF_3. As one proceeds in the series from BF_3 to BI_3, the amount of excited state varies in a regular manner and B^+ ions are completely in the ground state when BI_3 is used as a target. The composition of the beam could also be varied by varying the electron energy. The results of the attenuation studies were also confirmed by studying the cross section vs beam energy curves for the $B^+(^1S)$ and $B^+(^3P)$ reactions with N_2O. (auth)

13710 ASSOCIATIVE IONIZATION IN COLLISIONS OF METASTABLE HELIUM WITH H AND D. Magnuson, G.D.; Neynaber, R.H. (Intelcom Rad Tech, P.O. Box 80817, San Diego, California 92138). J. Chem. Phys. 60: No. 9, 3385-3387 (1 May 1974).

The exothermic reactions $He^* + H \rightarrow HeH^+ + e$ and $He^* + D \rightarrow HeD^+ + e$ have been studied by merging-beams techniques over a range of interaction energy W from 0.05–10 eV. The He^* represents a composite of He(2 ^{1}S) and He(2 ^{3}S). Data were obtained by observing currents due to the product ions. For each process the relative effective cross section Q_R (i.e., for the composite He^*) as a function of W is the same within experimental error and monotonically decreases with increasing W. The Q_R are in excellent agreement with theoretical predictions by Miller, Slocomb, and Schaefer for the reaction He(2 ^{3}S)+H–HeH$^+$+e. Absolute cross sections have also been extracted from the merging-beams data. These are in fair agreement with calculated values but lower than some recent crossed-beam results. (auth)

13711 LIFETIME AND QUENCHING RATE CONSTANTS FOR THE GREEN BANDS OF XeO. Tisone, G.C. (Sandia Laboratories, Albuquerque, New Mexico 87115). J. Chem. Phys. 60: No. 9, 3716-3717 (1 May 1974).

Measurements of the lifetime and quenching coefficients for the electronic transition between the metastable states $O(^1S_0)$ and $O(^1D)$ of XeO are reported. Mixtures of Xe and O_2 and mixtures of Xe and CO_2 were excited by a high energy electron beam. Relative intensities of the different vibrational transitions were measured in order to determine the transition probabilities. (AIP)

13712 RADIATIVE-LIFETIME AND ABSOLUTE-OSCILLATOR-STRENGTH STUDIES FOR SOME RESONANCE TRANSITIONS OF Si I, II, AND III. Curtis, L.J.; Smith, W.H. (Princeton University Observatory, Princeton, New Jersey 08540). Phys. Rev. A 9: No. 4, 1537-1542 (Apr 1974).

Radiative-lifetime studies have been carried out for resonance transitions of silicon I, II, and III in the ultraviolet using an electron-beam phase-shift apparatus. Lifetimes ranging from 0.03 to 220 nsec were determined. Significant discrepancies with earlier results were found for oscillator strengths of certain transitions, e.g., the Si II 1190–1194-Å multiplet, the Si II 1808-Å multiplet, and the Si III 1206-Å multiplet, which are important transitions in the establishment of the interstellar abundance of silicon. In making these measurements, some very short lifetimes were encountered, requiring that we make strenuous efforts to avoid errors in the reference phase. This led to redeterminations of the radiative lifetimes for the cascade-free transitions in Ne II at 462 Å and in N II at 1085 Å, with lifetimes of 0.15 ± 0.03 and 3.0 ± 0.1 nsec, respectively. (auth)

13713 $K\beta/K\alpha$ INTENSITY RATIOS FOR x-RAY PRODUCTION BY FAST DEUTERONS, α PARTICLES, AND CARBON IONS. Li, T.K.; Watson, R.L. (Department of Chemistry and Cyclotron Institute, Texas A&M University, College Station, Texas 77843). Phys. Rev. A 9: No. 4, 1574-1581 (Apr 1974).

Systematic measurements of $K\beta/K\alpha$ intensity ratios have been carried out for a wide range of targets ($19 \leq Z \leq 47$) using 2.35- to 12.5-MeV/amu deuterons, α particles, and carbon ions. Radiative-transition probability ratios were calculated for various L- and M-shell vacancy configurations using Hartree-Fock-Slater wave functions. Employing information previously obtained on simultaneous K- plus L-shell ionization, the velocity dependence of the simultaneous K- plus M-shell ionization probability was characterized and compared with the velocity dependence expected for ionization by direct Coulomb excitation. (auth)

13714 HIGH-RESOLUTION MEASUREMENT OF RESONANCES IN e–O_2 SCATTERING BY ELECTRON TIME-OF-FLIGHT SPECTROSCOPY. Land, J.E.; Raith, W. (J. W. Gibbs Laboratory, Yale University, New Haven, Connecticut 06520). Phys. Rev. A 9: No. 4, 1592-1602 (Apr 1974).

Resonances in the e–O_2 total cross section in the energy range 50–300 meV were studied with a high-resolution ($\Delta E < 10$ meV) electron time-of-flight spectrometer. Each vibrational resonance was found to have a well-resolved doublet structure, which has not previously been observed, and which is due to spin-orbit coupling in the $^2\Pi_g$ ground state of O_2^-. The spin-orbit coupling constant of O_2^- was measured to be $|A| = 20 \pm 2$ meV $= 161 \pm 16$ cm^{-1}, in agreement with theoretical estimates. On an energy scale established from the measured electron flight times, the energy of the center of the $v = 4$ resonance was measured to be 91 ± 5 meV. This value is in agreement with a recent photodetachment measurement of the electron affinity of O_2, and with a previously observed accidental coincidence between the $v = 3$ level of O_2 and the $v = 8$ level of O_2^-. The electron time-of-flight spectrometer is described in detail. (auth)

13715 RATIOS OF FORWARD TO BACK SCATTERING OF LOW-ENERGY ELECTRONS BY NEUTRAL GASES. Dehmel, R.C.; Fineman, M.A.; Miller, D.R. (Department of Applied Mechanics and Engineering Sciences and Institute for Pure and Applied Physical Sciences, University of California, San Diego, La Jolla, California 92037). Phys. Rev. A 9: No. 4, 1564-1568 (Apr 1974).

Measurements are reported on the ratio of forward to back scattering of electrons in the energy range 3–20 eV by He, O, Ar, H_2, N_2, and O_2 using the modulated crossed-beam technique. It is found that atomic oxygen has strong forward scattering at the lower energies. Agreement is found between the present results for He, Ar, H_2, and N_2 and ratios

calculated from previously published differential-cross-section measurements except for H_2 and N_2 at the lower-energy limit. (auth)

13716 CHARGE-CHANGING CROSS SECTIONS IN BORON OF 7-MeV ^{11}B RECOILS FROM THE ELASTIC SCATTERING OF DEUTERONS. Mason, E.V. Jr.; Wolke, R.L.; Debiak, T.W.; Yesso, J.D. (Wherrett Laboratory of Nuclear Chemistry, Department of Chemistry, University of Pittsburgh, Pittsburgh, Pennsylvania 15260). Phys. Rev. A 9: No. 4, 1569-1573 (Apr 1974).

Equilibrium and pre-equilibrium charge-state distributions have been measured for ^{11}B recoils at a velocity of 11.1×10^8 cm/sec from $^{11}B(d,d)$ elastic scattering in natural boron targets. A coupled set of linear differential equations describing the capture and loss of electrons has been derived for ions recoiling from nuclear processes in solids. It has been used to obtain electron-capture and -loss cross sections from the ^{11}B recoil data. The results are consistent with the existence of very little two-electron capture or loss and, when compared with previous results in gaseous media, do not show any pronounced effects of residual-ion excitation. (auth)

13717 Zn K- AND Pb L-SHELL IONIZATION BY PROTON AND ^3He-ION BOMBARDMENT. Tawara, H. (Department of Nuclear Engineering, Kyushu University, Fukuoka, Japan); Ishii, K.; Morita, S.; Kaji, H.; Hsu, C.N.; Shiokawa, T. Phys. Rev. A 9: No. 4, 1617-1625 (Apr 1974).

Absolute cross sections and excitation functions have been measured for Zn K-x-ray production by proton impact and for Pb L-x-ray production by proton and ^3He-ion impact over the bombarding energy range from 1.4 to 4.4 MeV using a Si(Li) detector. The total ionization cross sections for the Zn K shell and x-ray production cross sections for the Pb L shell obtained are compared with the binary-encounter approximation (BEA) and the plane-wave Born approximation calculations, and the agreement is found to be good. X-ray-production ratios, such as $L\alpha/L\beta$ and $L\alpha/L\gamma$, for Pb are also compared with the BEA calculations. The cross-over behavior of the Z_1 (projectile nuclear charge) dependence of the x-ray production cross sections was studied for the Pb L lines. (auth)

13718 VIRIAL THEOREMS FOR THE SCATTERING AMPLITUDE. McWhirter, J. D. G.; Moiseiwitsch, B. L. (Queen's Univ., Belfast). Acta Phys. Acad. Sci. Hung.; 35: No. 1-4, 37-45 (1974).

It is proved that if a scaling parameter is optimized using a variational principle for the scattering amplitude discovered by Schwinger, a virial theorem is satisfied by the optimized variational functions and the variationally determined scattering amplitude. Moreover it is shown that the virial theorem is satisfied by the first and second Born approximations to the scattering amplitude. (auth)

13719 ADDENDUM TO "VARIATIONAL FORMULATION OF THE R-MATRIX METHOD FOR MULTICHANNEL SCATTERING". Oberoi, R.S.; Nesbet, R.K. (IBM Research Laboratory, San Jose, California 95193). Phys. Rev. A 9: No. 6, 2804-2805 (June 1974).

Our recently published variational treatment of the R-matrix method for multichannel scattering requires computations involving unsymmetric matrices. An alternative derivation by Schlessinger and Payne has shown that the method can be reformulated in terms of symmetric matrices. Special techniques applicable to symmetric matrices simplify the computations and improve numerical accuracy. (auth)

13720 PARAMETER-VARIATION METHODS FOR ELASTIC-SCATTERING CALCULATIONS. Perkins, J.F. (U.S. Army Missile Command, Redstone Arsenal, Alabama 35809). Phys. Rev. A 9: No. 6, 2466-2473 (June 1974).

Extensive Kohn calculations by Schwartz demonstrated the power of the method but also the presence of anomalies involving spurious rapid variations in $\tan\eta$. Nesbet showed that anomalies result from the vanishing of a denominator, and he and others have proposed anomaly-free methods. Anomalies are analyzed herein by parametrizing the normalization of long-range expansion terms such that conventional direct and inverse Kohn methods are special cases. The functional dependence of the parametrized estimate on the normalization parameter is found to be of simple algebraic form. By appropriately averaging over this parameter, we obtain a generalized variational method which is anomaly free. Calculations for a simple model problem are used to test and illustrate properties of the several variational methods which are considered. (auth)

13721 ABSOLUTE H⁻ DETACHMENT CROSS SECTIONS. Risley, J.S.; Geballe, R. (Department of Physics, University of Washington, Seattle, Washington 98195). Phys. Rev. A 9: No. 6, 2485-2495 (June 1974).

Absolute detachment cross sections for 200-eV to 10-keV H^- on He, Ar, H_2, N_2, and O_2 were measured to an accuracy of 7% using the beam-attenuation method. The cross sections, approximately (5-25) $\times10^{-16}$ cm^2, all increase slowly with increasing collision energy, except for O_2, in which case the cross section decreases with increasing impact energies up to 4 keV. The present results are compared with previous measurements. A semiempirical theory based on low-energy-electron scattering predicts the detachment cross sections with some success. (auth)

13722 SINGLE AND DOUBLE ELECTRON LOSS BY FAST HELIUM ATOMS IN GASES. Hvelplund, P.; Pedersen, E.H. (Institute of Physics, University of Aarhus, DK-8000 Aarhus C, Denmark). Phys. Rev. A 9: No. 6, 2434-2439 (June 1974).

Measurements of single and double electron-loss cross sections for He atoms in the gases H_2, He, N_2, Ar, and Kr are reported in the energy range from 0.1 to 4 MeV. The cross sections are determined by the initial-growth method, and the neutral beam is formed by charge transfer neutralization of He^+ in a He gas. The results on single electron loss in H_2 and He targets have been discussed in an earlier paper and compared with theoretical Born-approximation calculations. The present results are compared with those from other experiments and with available theoretical estimates. (auth)

13723 DISTRIBUTION IN ENERGY AND ANGLE OF ELECTRONS EJECTED FROM XENON BY 0.3- TO 2.0-MeV PROTONS. Toburen, L.H. (Battelle Pacific Northwest Laboratory, Richland, Washington 99352). Phys. Rev. A 9: No. 6, 2505-2517 (June 1974).

Absolute cross sections, differential in electron energy and emission angle, have been measured for ejection of electrons from xenon by 0.3- to 2.0-MeV protons. Electron-energy distributions are presented for ten angles between 20° and 130°. Angular distributions are found to be more nearly isotropic than results for targets of lower atomic number. Cross sections differential in electron energy obtained by integration with respect to emission angle, are found to be in relatively good agreement with calculations based on binary-encounter theory. Auger electrons resulting from initial vacancies in the M and N shells of xenon are discussed. Estimates of total M- and N-shell ionization cross sections for fast protons are presented. (auth)

13724 GLAUBER CROSS SECTIONS FOR EXCITATION OF THE 2 ^1P STATE OF HELIUM BY ELECTRON IMPACT. Chan, F.T.; Chen, S.T. (Physics Department, University of Arkansas, Fayetteville, Arkansas 72701). Phys. Rev. A 9: No. 6, 2393-2397 (June 1974).

Recently developed analytic methods, which reduce the Glauber amplitude for charged-particle-neutral-atom collisions to a one-dimensional integral representation involving modified Lommel functions, are used to evaluate the cross sections for the direct excitation of the 2 ^1P state of helium by electron impact with incident energies from 55.5 to 900 eV. The theoretical results for the differential and total excitation cross sections are in good agreement with the experimental data. In particular, the Glauber theory predicts a peak value for the total excitation cross sections around 80 eV which is consistent with the existing experimental findings, whereas other theoretical models give monotonically increasing values with decreasing energy below 100 eV. (auth)

13725 SINGLE-ELECTRON EXCITATION AND TRANSFER IN COLLISIONS OF ALKALI-METAL AND OXYGEN ATOMS. Vora, R.B.; Turner, J.E.; Compton, R.N. (Health Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). Phys. Rev. A 9: No. 6, 2532-2544 (June 1974).

An approximate theory is given for calculating the cross sections for single-electron excitation and transfer from a neutral alkali-metal atom M colliding with atomic oxygen. The trajectories of the colliding atoms are computed classically, and the electron is treated by the time-dependent Schrödinger equation in two- and three-state approximations. The three states considered are the ground and first-excited states M and M* of the incident atom and the single bound state of O^-. Numerical calculations are carried out for energies between 10 and 10000 eV (laboratory energies of the alkali-metal atoms). Comparison of results obtained with the two- and three-state approximations shows that the charge-transfer cross sections are almost unaffected by the presence of the alkali-metal-atom excited state. The excitation cross sections, on the other hand, are considerably increased by the presence of the ionic channel. This evidence indicates that excitation can occur as a two-step process in which the electron is exchanged between the colliding partners. The numerical values of the electron-transfer cross section generally agree with those calculated by van den Bos for Cs-O collisions (based on the Landau-Zener-Stückelberg theory and suitably corrected by a statistical weight factor) and the recent experimental data of Woodward. At low velocities ($v < 0.01$ a.u.), however, we find a steeper decrease with decreasing velocity than the Landau-Zener-Stückelberg results. At high velocities the results agree with the Born approximation. (auth)

13726 ABSOLUTE CROSS SECTIONS FOR ELECTRON-IMPACT EXCITATION OF N_2^+. Crandall, D.H.; Kauppila, W.E.; Phaneuf, R.A.; Taylor, P.O.; Dunn, G.H. (Joint Institute for Laboratory Astrophysics, University of Colorado and National Bureau of Standards, Boulder, Colorado 80302). Phys. Rev. A 9: No. 6, 2545-2551 (June 1974).

Crossed beams of N_2^+ and electrons were used to measure the absolute cross sections for the excitation, $N_2^+(X\ ^2\Sigma_g^+, v=0) + e -$

$N_2^+(B\ ^2\Sigma_u^+, v=0) + e$, over an electron energy range from below threshold (3.17 eV) to 91 eV. Absolute emissions of the 391.4-nm band were measured from impact of electrons on N_2^+ ions in various state mixtures. Corrections were made to the data to account for state mixtures and other effects to obtain the cross section for the above process. The cross section falls from its finite threshold value of 3.0×10^{-16} to 0.30×10^{-16} cm^2 at 91 eV. The present values are more than an order of magnitude smaller than either the 1968 values of Lee and Carleton or the 1973 values of Daschenko et al. At threshold the Gaunt-factor formula of Seaton predicts a value only 45% of that measured, but at the highest energy, the predictions of the Seaton formula have converged to within 20% of the present values of the cross section. Rate coefficients calculated from the present measurements are consistent with the recent rate-coefficient measurements of McLean et al. Total uncertainty at high confidence is about 18%, taken as the quadrature sum of random uncertainty (15% at 98% confidence level) with systematic uncertainties (about 8% at high confidence). The analysis leading to interpretation of the emission cross section in terms of an excitation cross section between specific states is subject to uncertainties which are not well defined, and are not included in the stated uncertainty. (auth)

13727 MEASUREMENTS OF INELASTIC ENERGY LOSS AND K-VACANCY PRODUCTION IN ATOMIC COLLISIONS AT keV ENERGIES AND LARGE SCATTERING ANGLES. Fastrup, B.; Hermann, G.; Kessel, Q.; Crone, A. (Institute of Physics, University of Aarhus, DK-8000 Aarhus C, Denmark). Phys. Rev. A 9: No. 6, 2518-2531 (June 1974).

The differential inelastic energy loss Q has been determined for keV atomic collisions between Na^+, Ne^+, Ne^{++}, F^+, O^+, and N^+ projectiles and Ne, N_2, and NH_3 targets for scattering angles between 2° and 15°. The data, which have been obtained under single-collision conditions, determine the probability of producing a K vacancy and the corresponding K-excitation energy for specified charge states of the projectile before and after the collision. The production of a K vacancy has been shown to take place preferentially in the low-Z collision partner with a probability depending on the collision's distance of closest approach and the projectile velocity. The data suggest that rotational coupling between the $2p\sigma$ molecular orbital (MO) and the $2p\pi$ MO produces the K vacancy. The K-excitation probability is shown to depend strongly on the outer-shell (2p), precollisional configuration of the high-Z collision partner. For N^+-NH_3, Ne^+-Ne, Ne^{++}-Ne, and Na^+-Ne collisions, the maximum K-excitation probabilities are 35%, (10-15) %, 20%, and < 1%, respectively. These observations are in accord with the Fano-Lichten model. For N^+ and O^+ projectiles incident on N_2 and NH_3 targets, triple-peaked Q spectra occur, indicating a fair probability of the production of two K vacancies. For asymmetric collision systems such as O^+-NH_3, the two K vacancies are produced preferentially in the low-Z collision partner. (auth)

13728 EIKONAL OPTICAL-MODEL THEORY OF ELASTIC ELECTRON-ATOM SCATTERING. Byron, F.W. Jr. (Department of Physics, University of Massachusetts, Amherst, Massachusetts 01002); Joachain, C.J. Phys. Rev. A 9: No. 6, 2559-2568 (June 1974).

We analyze elastic electron-atom scattering at intermediate and high energies by using a second-order optical-model potential together with the eikonal approximation. We devote particular attention to the role of long-range forces and formulate the theory in a way suitable for generalizations to complex target atoms. We also study the relationship between the optical eikonal model and the Born series, and include exchange effects to leading order in the inverse power of the energy. Our optical-model theory is then illustrated by a detailed analysis of elastic electron-helium scattering for incident electron energies ranging from 100 to 500 eV. We find excellent agreement with experimental data without using any phenomenological parameter. (auth)

13729 DIFFERENTIAL CROSS SECTION FOR ELASTIC SCATTERING OF ELECTRONS FROM ATOMIC HYDROGEN: LOW ENERGIES. Teubner, P.J.O.; Lloyd, C.R.; Weigold, E. (School of Physical Sciences, The Flinders University of South Australia, Bedford Park, 5042, South Australia). Phys. Rev. A 9: No. 6, 2552-2558 (June 1974).

Differential cross sections for the elastic scattering of electrons from atomic hydrogen have been measured at 9.4, 12, and 20 eV. The data at 9.4 eV are shown to agree with a previous measurement and to agree with the prediction of the close-coupling approximation even at the smaller scattering angles of the present experiment. The data at 12 eV agree very well with the six-state close-coupling calculation. The data at 20 eV agree well with a three-state calculation except at the most forward angles. (auth)

13730 SCATTERING OF ELECTRONS BY HYDROGEN ATOMS AT INTERMEDIATE ENERGIES. Callaway, J.; Wooten, J.W. (Department of Physics and Astronomy, Louisiana State University, Baton Rouge, Louisiana 70803). Phys. Rev. A 9: No. 5, 1924-1931 (May 1974).

The algebraic variational method has been applied to the scattering of electrons by hydrogen atoms at intermediate energies. The atom was represented by an eleven-state expansion, including exact 1s, 2s, 2p, and 3d states plus seven pseudostates. The pseudochannels are allowed to be open. Results are presented for 1s-2s and 1s-2p excitations for energies between 10 and 12 eV, and for 1s-1s elastic scattering from 10 to 30 eV. (auth)

13731 DIFFERENTIAL CROSS SECTIONS FOR ELASTIC SCATTERING AND FOR THE 2s AND 2p EXCITATIONS OF H(1s) BY HYDROGEN-ATOM IMPACT. Flannery, M.R.; McCann, K.J. (School of Physics, Georgia Institute of Technology, Atlanta, Georgia 30332). Phys. Rev. A 9: No. 5, 1947-1953 (May 1974).

Differential cross sections are calculated using the two-state and four-state impact-parameter treatments for H(1s)—H(1s) elastic and inelastic collisions in the keV-energy region. The cross sections, computed as a function of scattering angle, are compared with those evaluated from the Born-wave and unitarized-Born approximations. Interesting differences are observed. (auth)

13732 COUPLED EQUATIONS FOR MEDIUM-ENERGY SCATTERING. II. ELECTRON AND POSITRON SCATTERING FROM ATOMIC HYDROGEN. Hahn, Y. (Department of Physics, University of Connecticut, Storrs, Connecticut 06268). Phys. Rev. A 9: No. 5, 2024-2035 (May 1974).

The effective-channel approach to medium-energy scattering has been formulated previously by constructing a set of coupled equations for the elastic-scattering and average inelastic-scattering channels, with the evaluation of the average fluctuation potential and the average excitation energy to be carried out by a variational procedure. The formalism is applied here to the electron and positron scattering from atomic hydrogen in the energy range 50-500 eV. The various quantities which parametrize the effective channel are explicitly calculated. An approximate solution of the coupled equations is then obtained using a set of Green's functions in the semiclassical approximation. Contributions to the elastic-scattering amplitude which arise from the static interaction and the coupling to the average inelastic-scattering channel are isolated for the purpose of ready comparison with previous calculations. The present calculation contains, in effect, no free adjustable parameters when the information from the total-cross-section data is incorporated into the theory through the use of the optical theorem. (auth)

13733 ELECTRON CAPTURE INTO THE n = 3,4 STATES OF H BY LOW-ENERGY H^+, H_2^+ IMPACT ON GASES. Hess, W.R. (Centre d'Etudes Nucléaires de Grenoble, Département de Physique du Plasma et de la Fusion Contrôlée, Service d'Ionique Générale, Grenoble, France). Phys. Rev. A 9: No. 5, 2036-2042 (May 1974).

Absolute cross sections for electron capture into the n = 3,4 states of H have been measured for 0.3-3.0-keV H^+, H_2^+ impact on H_2, N_2, Ar, CO_2. This cross section decreases exponentially with decreasing impact velocity according to an $\sigma = A \exp(-B|\Delta E|/v)$ relationship, where $|\Delta E|$ is the internal energy of the reaction, v is the ion velocity, and A and B are constant. (auth)

13734 COUPLED EQUATIONS FOR MEDIUM-ENERGY SCATTERING. I. Hahn, Y. (Department of Physics, New York University, New York, New York 10003). Phys. Rev. A 9: No. 5, 2014-2023 (May 1974).

A simple set of coupled equations applicable for medium-energy scattering by composite systems is derived. The scattering function is expanded in the basis functions such that the average inelastic-scattering channels simulate both adiabatic and impulse limits. Detailed discussions are given on the construction of the basis functions by the sum-rule technique. A procedure to solve the coupled set of equations by the Green's functions is presented, and the evaluation of the amplitude using the angle-averaging method is outlined. (auth)

13735 ELECTRON EXCITATION OF ELECTRONIC STATES OF CO MOLECULE. Chung, S.; Lin, C.C. (Department of Physics, University of Wisconsin, Madison, Wisconsin 53706). Phys. Rev. A 9: No. 5, 1954-1964 (May 1974).

The electron-impact excitation cross sections of the A $^1\Pi$, E $^1\Pi$, B $^1\Sigma^+$, C $^1\Sigma^+$, D $^1\Delta$, a $^3\Pi$, c $^3\Pi$, b $^3\Sigma^+$, j $^3\Sigma^+$, a' $^3\Sigma^+$, and d $^3\Delta$ states of the CO molecule have been calculated for the incident electron energies over the range of threshold to 1000 eV for the singlet states and up to 100 eV for the triplet states by means of the Born approximation with Ochkur's and Rudge's modification for treating electron-exchange scattering. The wave functions of the various electronic states used in this calculation were determined by the self-consistent-field procedure with the Gaussian-type orbitals as basis functions. The calculated generalized oscillator strengths of the A $^1\Pi$, E $^1\Pi$, and C $^1\Sigma^+$ state are in reasonable agreement with the experimental values of Lassettre et al., but a larger discrepancy is found for the B $^1\Sigma^+$ state. The total cross sections calculated by this scheme show satisfactory agreement with experiment (30% at 300 eV) for the A $^1\Pi$ state and are generally within the range of uncertainty of the experimental data for a $^3\Pi$. For the B $^1\Sigma^+$ and b $^3\Sigma^+$ states the theoretical cross sections differ very significantly from the experimental data of Skubenich which, however, are in serious disagreement with measurements reported from two other laboratories. (auth)

13736 INTERMOLECULAR POTENTIAL BETWEEN A HYDROGEN MOLECULE AND AN IODINE ATOM. Wong, Y.C.; Lee, Y.T. (The James Franck Institute and Department of Chemistry, The University of Chicago, Chicago, Illinois 60637). J. Chem. Phys. 60: No. 11, 4619-4620 (1 June 1974).

Elastic differential scattering cross sections were measured for collisions of deuterium molecules and iodine atoms in a crossed beam system. The results were analyzed by finding the best parameters for a Lennard-Jones (N-6) potential. (AIP)

13737 SEMICLASSICAL TREATMENT OF ELECTRONIC TRANSITIONS IN MOLECULAR COLLISIONS: COLLINEAR $H^+ + D_2 - HD^+ + D$. Lin, Y.; George, T.F.; Morokuma, K. (Department of Chemistry, The University of Rochester, Rochester, New York 14627). J. Chem. Phys. 60: No. 11, 4311-4322 (1 June 1974).

A semiclassical treatment is presented for the dynamics of the collinear reaction $H^+ + D_2 - HD^+ + D$ as occurring by transition from the ground to the first excited singlet electronic state of the HD^+_2 system. The potential energy surfaces corresponding to the two singlet states of the same symmetry have an avoided intersection for real values of nuclear coordinates, and the surfaces are analytically continued to the complex intersection. Complex-valued classical trajectories are integrated on the analytically continued surfaces, and an electronic transition is effected by a trajectory switching surfaces continuously at the complex intersection. From the complex action calculated along appropriate trajectories, the classical limit of S-matrix elements is calculated for transitions from the ground vibrational state of D_2 to the ground and first excited vibrational states of HD^+ for initial relative translational energies in the range 3–6 eV. These two vibrational states of HD^+ differ in that the energy of the ground state lies below the asymptotic real intersection point of interest of the two surfaces while the first excited state lies above the real intersection point. Furthermore, transition points, which are points in time when a trajectory switches surfaces, occur close together in pairs for the transition to the ground vibrational state of HD^+, whereas transition points are well separated for the transition to the first excited vibrational state of HD^+. The differences of the transitions to these two vibrational states of HD^+ result in different dynamical behavior of the trajectories leading to these transitions and require different expressions for the classical limit of the S-matrix elements. (auth)

13738 ELECTRON-IMPACT EXCITATION OF THE $^3S^0$ AND $^5S^0$ STATES OF ATOMIC OXYGEN. Stone, E.J.; Zipf, E.C. (Department of Physics, University of Pittsburgh, Pittsburgh, Pennsylvania 15260). J. Chem. Phys. 60: No. 11, 4237-4243 (1 June 1974).

Absolute cross sections for the excitation of the OI $3s(^3S^0)$ and $3s(^5S^0)$ states by electron impact on atomic oxygen have been measured for electron energies from threshold to 300 eV. The magnitude of the $^3S^0$ cross section is 5.3×10^{-17} cm$^2\pm$40% at its peak at 20 eV. This cross section differs in magnitude and shape from the result reported earlier. The $^5S^0$ cross section has a maximum value of 2.5×10^{-17} cm$^2\pm$50% at 15 eV. Both cross sections are larger than the values predicted by recent theoretical calculations. The experimental techniques used in the production of atomic oxygen and in the measurement of the OI density have been improved and are described in detail. Critical experimental problems concerning the loss of atoms at the system walls and the role of excited states of O_2 in the discharged gas are also discussed. (auth)

13739 ITERATIVE SOLUTIONS OF THE CLOSE-COUPLED EQUATIONS THAT APPEAR IN THE PROBLEM OF ROTATIONAL EXCITATION OF A RIGID ROTOR. Nanbu, K. (Institute of High Speed Mechanics, Tohoku University, Sendai, Japan). J. Chem. Phys. 60: No. 11, 4520-4524 (1 June 1974).

A method to solve iteratively the close-coupled equations that appear in the theory of scattering of an atom by a rigid rotor is proposed. It is a natural extension of the distorted-wave approximation method (DWA). The total cross sections obtained by the present method agree well with those of Johnson and Secrest. Iterative solutions converge rapidly. As for computer execution time, it depends upon the number of coupled equations. If only the open channels are taken into consideration, it takes only 20–30% more for the present method than for the DWA method. However, if the closed channels are also taken into consideration, it takes 90–100% more than for the DWA method. (auth)

13740 HIGH RESOLUTION DIFFERENTIAL CROSS SECTIONS AND INTERMOLECULAR POTENTIALS I: Li–Kr AND Li–Xe. Auerbach, D.J. (Department of Physics and James Franck Institute, The University of Chicago, Chicago, Illinois 60637). J. Chem. Phys. 60: No. 11, 4116-4122 (1 June 1974).

High resolution differential cross sections for the systems Li–Kr and Li–Xe have been measured with resolution sufficient to obtain the amplitudes as well as the positions of all features including the highest frequency oscillations in $d\sigma/d\Omega$. Two different relative velocities per system were selected for measurement in the range from $1–3\times10^5$ cm/sec. The data were analyzed by fitting model potentials. Values obtained for the range and depth parameters of the potential are $r_m=4.78$ Å, $\epsilon=1.35\times10^{-4}$ erg for Li–Kr, $r_m=4.80$ Å, $\epsilon=2.03\times10^{-14}$ erg for Li–Xe. The data are of sufficient quality to yield additional information about the shape of the intermolecular potential. (auth)

13741 ELECTRON-IMPACT-IONIZATION CROSS SECTIONS OF INNER SHELLS MEASURED BY AUGER-ELECTRON SPECTROSCOPY. Vrakking, J.J.; Meyer, F. (Philips Research Laboratories, Eindhoven, The Netherlands). Phys. Rev. A 9: No. 5, 1932-1937 (May 1974).

Absolute values of inner-shell ionization cross sections have been obtained by electron impact using Auger-electron spectroscopy with gaseous samples. Values of the $L_{2,3}$-shell cross sections of Si, P, S, Cl, and Ti and the $M_{4,5}$-shell cross sections of Br and Sn are reported for incident-electron energies between 500 and 2500 eV. The corrections due to a hole redistribution by Coster–Kronig transitions are discussed. (auth)

13742 ANALYSIS OF SCATTERING AND EXCITATION AMPLITUDES IN POLARIZED-ELECTRON–ATOM COLLISIONS. II. SCATTERING ON TWO-ELECTRON ATOMS. Blum, K.; Kleinpoppen, H. (University of Stirling, Stirling, Scotland). Phys. Rev. A 9: No. 5, 1902-1908 (May 1974).

A general analysis of polarization effects, resulting from exchange collisions between electrons and two-electron atoms, is given using density-matrix techniques. The formalism is presented in some detail. In particular, collisions on spin-1 atoms are discussed. General equations are derived which relate the quantities, characterizing the polarization state of the final beam, to their counterparts before scattering. Both sets of quantities are connected by functions of the scattering amplitudes. Thus, from these general equations we can read off what information can be extracted from experiments with particles in any given initial polarization state. Furthermore, some of the obtained expressions may be useful in discussions of other reactions, for example, processes in which spin–orbit and tensor interactions are important. (auth)

13743 VIBRATIONAL EXCITATION IN NONIONIZING ION–MOLECULE COLLISIONS AT $2–7\times10^7$ cm/sec. Moore, J.H., Jr. (Chemistry Department, University of Maryland, College Park, Maryland 20742). Phys. Rev. A 9: No. 5, 2043-2048 (May 1974).

The vibrational-state population of electronically excited, neutral molecules produced by ion impact at $2–7\times10^7$ cm/sec has been determined by measuring the relative intensities of the vibrational components of electronic band systems observed in the energy-loss spectra of H^+, H_2^+, and N^+ scattered from N_2 and CO. The measured intensities agree with intensities which have been observed in optical and electron-impact spectra as well as with theoretical predictions based on the Franck–Condon principle. Previous reports of anomalous vibrational excitation of $N_2(a\ ^1\Pi_g)$ by proton impact are demonstrated to be the result of proton-impact excitation of N_2 to both the a $^1\Pi_g$ and w $^1\Delta_u$ states. (auth)

13744 TOTAL CROSS SECTIONS FOR CHARGE TRANSFER FOR F^+ IN H_2, N_2, He, Ne, AND Ar. Lockwood, G.J. (Sandia Laboratories, Albuquerque, New Mexico 87115). Phys. Rev. A 9: No. 5, 1916-1919 (May 1974).

Absolute measurements are reported of the total cross section σ_{10} for charge transfer of F^+ in H_2, N_2, He, Ne, and Ar in the energy range from 14 to 100 keV. The measured cross sections are in qualitative agreement with theory. However, it is observed that the slopes of the cross section versus velocity for velocities above the maximum in the cross sections differ for molecular and atomic targets used in this study. (auth)

13745 CHARGE-EXCHANGE CROSS SECTIONS FOR Ne^+ AND Ar^+ INCIDENT ON Cs. Meyer, F.W.; Anderson, L.W. (University of Wisconsin, Madison, Wisconsin 53706). Phys. Rev. A 9: No. 5, 1909-1915 (May 1974).

Total charge-exchange cross sections have been measured for Ne^+ and Ar^+ incident on Cs vapor. Ion beam energies for Ne^+ incident on Cs were in the energy range 1.72–40.2 keV. The cross section σ_{+0} for the incident Ne^+ ions has the almost constant value of $(540\pm60)\times10^{-17}$ cm^2 in the energy range 1.72–7.0 keV. The cross section increases from the 7 to 20 keV, reaching another plateau of $(1010\pm70)\times10^{-17}$ cm^2 in the energy range 20–40.2 keV. Ion beam energies for the Ar^+ ions incident on Cs were in the energy range 1.44–28.7 keV. The cross section σ_{+0} is $(710\pm63)\times10^{-17}$ cm^2 at 1.44 keV. The cross section increases between 1.44 and 8.6 keV, reaching a plateau of $(1020\pm90)\times10^{-17}$ cm^2 in the energy range 8.6–28.7 keV. (auth)

13746 ELECTROIONIZATION SPECTRUM OF O_2. Carbonneau, R.; Marmet, P. (Physics Department, Laval University, Quebec 10, Canada). Phys. Rev. A 9: No. 5, 1898-1901 (May 1974).

New structures detected in the electroionization spectrum of O_2 are explained as $3l\sigma$ Rydberg states belonging to the series converging to the recently reported ~24-eV $^2\Pi_u$ state of O_2^+. Some O_2^- resonances related to these Rydberg states are observed with an electronic affinity of ~0.5 eV. Numerous other structures, also appearing from 12.06 to 18 eV, originate from direct ionization and unresolved vibration of autoionizing states. (auth)

13747 COLLISIONAL IONIZATION OF CESIUM: RELAXATION OF PRODUCT FRAGMENTS. Tang, S.Y.; Rothe, E.W. (Research Institute for Engineering Sciences and Department of Chemical Engineering, Wayne State University, Detroit, Michigan 48202); Reck, G.P. J. Chem. Phys. 60: No. 10, 4096-4097 (15 May 1974).

The reaction $Cs+XF_3 \rightarrow Cs^+ + XF_2 + F^-$ (X=B and P) is studied by measuring the F^- production in a crossed beam system. The energy threshold obtained indicates the presence of relaxed products. (AIP)

13748 ANGULAR DISTRIBUTIONS OF PENNING IONS IN CROSSED BEAMS. II. $He^*(2\,^1S) + H_2$, N_2, CO, and O_2. Leu, M.T.; Siska, P.E. (Department of Chemistry, University of Pittsburgh, Pittsburgh, Pennsylvania 15260). J. Chem. Phys. 60: No. 10, 4082-4083 (15 May 1974).

Differential scattering is studied for collisions of He^* ($2\,^1S$) with H_2, N_2, CO, and O_2 by measuring the angular distribution of Penning ion products in a crossed beam system. The results indicate that there is a double minimum potential barrier in the excited state over which many of the Penning transitions take place for collisions of $He^* + H_2$, N_2, and CO; however, it is lowered or absent for $He^* + O_2$. (AIP)

13749 ELECTRON DETACHMENT IN LOW-ENERGY COLLISIONS OF H^- AND D^- WITH He. Lam, S.K.; Delos, J.B.; Champion, R.L.; Doverspike, L.D. (Department of Physics, College of William and Mary, Williamsburg, Virginia 23185). Phys. Rev. A 9: No. 5, 1828-1839 (May 1974).

Measurements and calculations have been made of elastic scattering and electron detachment in collisions of H^- and D^- with He at energies of 5–120 eV. The measurements show no other inelastic processes occurring in this energy range. The mechanism responsible for electron detachment is assumed to be the crossing of the H^- bound state with the continuum of free states; the bound state is then assigned a complex energy. The measured elastic scattering differential cross section shows no structure except at $E\theta \sim 200$ eV deg, where there is a region of downward curvature in the graph of $\log\sigma$ vs θ. This is interpreted as the threshold angle for electron detachment, and it is directly related to the crossing point. By empirically fitting the experimental differential cross section, the general features of the complex potential were obtained. By using the resulting potentials, the total detachment cross section was calculated and compared to the experimental results of Bailey, May, and Muschlitz. Only fair agreement is found at low energies, and poor agreement at higher energies (>100 eV). The theory predicts an isotope effect in the elastic differential cross section, and this effect provides a test of the theory. A careful series of experiments at 20 eV displayed the effect. A preliminary measurement of the electron energy spectrum was also made. (auth)

13750 DIFFERENTIAL ELASTIC SCATTERING OF POTASSIUM ATOMS BY ATOMIC IODINE AT THERMAL ENERGIES. Kaufmann, K.J.; Lawter, J.R.; Kinsey, J.L. (Department of Chemistry, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). J. Chem. Phys. 60: No. 10, 4016-4022 (15 May 1974).

The differential scattering of potassium atoms by atomic iodine has been measured in both the in-plane and out-of-plane mode. The energy range covered was 0.08–0.2 eV. The angular dependence was measured between 2° and 108° (center of mass). A semiclassical synthesis of the observed scattering from assumed potential curves gives insight into the nature of the covalent potentials for potassium iodide. (auth)

13751 POTENTIAL SURFACE DEPENDENCE OF VIBRATIONALLY INELASTIC COLLISIONS BETWEEN He AND H_2. Alexander, M.H.; Berard, E.V. (Department of Chemistry, University of Maryland, College Park, Maryland 20742). J. Chem. Phys. 60: No. 10, 3950-3957 (15 May 1974).

We have carried out a careful study of $He-H_2$ vibrationally inelastic collisions based on five different analytic fits to the Gordon-Secrest [J. Chem. Phys. 52, 120 (1970)] ab initio interaction potential. Within a model which freezes the atom-diatom orientation, we solve the collision dynamics fully quantum mechanically. Both for the 0–1 and 3–4 vibrational transitions, we find that the use of different analytic surfaces leads to substantial qualitative and quantitative differences in the calculated transition probabilities. In particular, we observe an anomalous angular dependence in the case of the original Gordon-Secrest analytic surface. We show that this arises from difficulties in the extrapolation of the ab initio points in the classically forbidden region at small center-of-mass separation. These results have important implications for future theoretical study of molecular collisions. (auth)

13752 DISCRETE METHODS IN QUANTUM SCATTERING THEORY. Heller, E. J. Cambridge, MA; Harvard Univ. (1973). 259p. University Microfilms Order No. 74-5783.

Thesis (Ph. D.).

The Fredholm integral equation method applied to the singular Lippmann-Schwinger equation is examined. A "dispersion-correction" formula is derived for the Fredholm determinant, removing all error arising from the singular kernel. These ideas are extended to allow evaluation of the integral equation in a discrete L^2 basis. An interpolation scheme is developed involving the Fredholm determinant which, for example, finds use as a means of expanding the information content of Hazi-Taylor stabilization calculations. The Wigner-Eisenbud R-matrix theory is successfully applied to collinear inelastic atom-diatom collisions, and narrow Feshbach resonances in this system are easily found and characterized. Then, noting that the usual R-matrix method (even with Buttle correction) suffers difficulties of convergence, a variational correction scheme is developed which provides second order stability at all energies to the single and multichannel Buttle corrected R-matrix and yields at the same time a multi-channel unitary R-matrix perturbation theory which includes the effect of channel coupling. A new L^2 approach to scattering is developed which exploits the infinite soluble Jacobi (tri-diagonal) matrix problem generated by evaluating a zeroth order scattering Hamiltonian H_0 in a certain Laguerre (Slater) basis. Phase shifts, wave functions, Green's functions, and bound states which are exact for a full Hamiltonian H in which only the potential is approximated (to arbitrary accuracy) are obtained. Only bound-bound matrix elements of the potential are needed; there are no Kohn-type pseudoresonances; the results may be Kato corrected, and only finite matrix manipulations are needed. This method is applied to singlet electron-hydrogen scattering (s-wave) above and below the ionization threshold, using up to ten pseudo-states for hydrogen. Discrete pseudo-state methods are developed for collisions with targets possessing continuous channels. A quadrature over channels approach is developed. Nonperturbative calculations are performed on an atom colliding with an N-atom harmonic chain (with N up to 11); this system is shown to be equivalent to an N-point Gaussian quadrature over channels approximation to an atom-infinite chain collision. Methods for removing anomalous pseudo-state threshold behavior and interpreting transitions to and among the pseudo-states are discussed. (Diss. Abstr. Int., B)

13753 ELECTRON EXCITATION OF MOLECULAR HYDROGEN, CARBON MONOXIDE, AND MOLECULAR NITROGEN. Lawton, S. A. Amherst, MA; Univ. of Massachusetts (1973). 196p. University Microfilms Order No. 74-7588.

Thesis (Ph. D.).

A hemispherical electron monochromator was used to study the photon and metastable excitation functions for electron excitation of molecular hydrogen, carbon monoxide, and molecular nitrogen. The energy resolution obtained with the monochromator was approximately .050 eV. Photons emitted in the decay of the $B^1\Sigma_u^+$ state of H_2 were observed for incident electron energies of 11 to 13 eV. Two series of resonances in the $B^1\Sigma_u^+$ excitation function were studied: a strong series at 11.30, 11.61, 11.90, 12.19, 12.47, 12.71, and 12.93 eV, and a weaker series at 11.46, 11.92, 12.02, 12.29, and 12.55 eV. These structures are identified with the series I and series II type I Feshbach resonances observed in previous transmissions and energy-loss experiments. The resonances are due to vibrational excitation of the two H_2^- states consisting of an electron added to the $c^3\Pi_u$ (series I) and $C^1\Pi_u$ (series II) states of H_2. The energies and relative intensities of these resonances are compared with those observed by McGowan and Williams in a previous study of the excitation of the $B^1\Sigma_u^+$ state. Results imply that the energy scale of these authors was miscalibrated by approximately 100 MeV. The total excitation function for CO from threshold to 12 eV was observed. Below 10.5 eV the excitation function observed was primarily that of the $A^1\Pi$ state, and a resonance was observed in this channel at 10.04 eV. A strong threshold at 10.78 eV is attributed to excitation of the $B^1\Sigma^+$ state. No evidence was found for previously reported long-lived states with thresholds in the region of 10 eV. The metastable excitation function for molecular nitrogen was observed from threshold to 14 eV with an energy resolution of .050 eV. No resonance structure was noted below 11.8 eV in the $A^3\Sigma_u^+$ and $a^1\Pi_g$ channels. A sharp resonance in the $E^3\Sigma_g^+$ channel was observed to peak at 12.00 eV. A smaller secondary resonance was seen at 12.14 eV. A series of five resonances was observed at 12.61, 12.84, 13.08, 13.31, and 13.55 eV. The positions of these resonances are compared with those observed in energy-loss and transmission experiments. These resonances are attributed to excitation of the vibrational levels of the N^- state consisting of two Rydberg electrons bound to a N_2^+ $A^2\Pi_g^+$ core. Absolute cross sections for excitation of the $B^1\Sigma^+$ state in CO and the $E^3\Sigma_g^+$ state in N_2 were obtained by comparison of the relative excitation functions of these states with the known absolute excitation cross section for metastable He. The peak cross section at 11.3 eV for excitation of the $B^1\Sigma^+$ state was found to be $(3.1^{+}_{-}) \times 10^{-18}$ cm^2. The peak $E^3\Sigma_g^+$ cross section at 12.00 eV was determined to be $(1.9^{+}_{-}) \times 10^{-17}$ cm^2. The $B^1\Sigma^+$ cross section is consistent with the value 3×10^{-18} cm^2 obtained by Skubenich from spectral

line intensities. A previous determination of the $E^3\Sigma_g^+$ cross section by Borst is shown to underestimate the correct value. (Diss. Abstr. Int., B)

13754 ELECTRON-IMPACT EXCITATION CROSS SECTIONS FOR ATOMIC OXYGEN. Rountree, S. P. Baton Rouge; Louisiana State University (1973). 107p. University Microfilms Order No. 74-7257.

Thesis (Ph. D.).

The angular momentum recoupling coefficients which arise in the close-coupling treatment of electron-atom scattering are classified and evaluated. The electron-impact excitation cross sections for $O(^3P\text{-}3s\ ^3S^o)$ are calculated in the unitarized Born, nonexchange, and close-coupling approximations. The close-coupling cross sections have the same energy dependence as measurements by Stone and Zipf, but are lower in magnitude by a factor of 4. Two autodetaching levels, $0^-\ 2p\ ^3(^4S)3s^2(^4S^o)$ and $0^-\ 2p^3(^4S)3s3p(^2P)$, are found at 10.61 and 9.66 eV, respectively. In comparison with other works, the energies of these autodetaching levels are too high. This is as expected and the sources of error are indicated. Finally, suggestions are given for improvement of electron-atom scattering calculations in future work. (Diss. Abstr. Int., B)

13755 NONITERATIVE INTEGRAL-EQUATION APPROACH TO SCATTERING PROBLEMS. Smith, E. R. Baton Rouge; Louisiana State University (1973). 79p. University Microfilms Order No. 74-7262.

Thesis (Ph. D.).

A procedure which allows for both open and closed channels with exchange, correlation, and orthogonality is formulated for a multichannel scattering process. Noniterative integral equation theory is used to solve the coupled integro-differential equations of the scattering problem from zero out to some transformation point where the reactance matrix is projected out to its asymptotic value by using a matricant technique. The method is applied to a two-channel model which has some of the features of a 1s–2p close coupling approximation for e-H scattering. S-wave scattering of electrons by atomic hydrogen, and P-wave scattering of electrons by atomic oxygen. (Diss. Abstr. Int., B)

13756 ELECTRON SCATTERING FROM THE H^- ION AND He ATOM. Thomas, L. D. Los Angeles; Univ. of Southern California (1974). 114p. University Microfilms Order No. 74-11,711.

Thesis (Ph. D.).

A discussion is given of the use of square integrable basis functions for representing scattering states of atomic systems. The discussion leads naturally to a definition of the stabilization method for locating resonant states of negative ions. Finally, results are presented for the use of the stabilization method for locating two resonant states of H—at 14.89 and 17.26 eV, both in excellent agreement with experiment. Results are presented for the excitation cross sections of the 2^1S, 2^3S, 2^1P, and 2^3P states of He for the incident electron energy range 29.6 to 81.63 eV. These results are the first application of the many-body Green's function technique to inelastic scattering. Comparison to the recent accurate measurement of Trajmar and to previous calculations shows the first-order formula to give quantitative results for the 2^1P excitation above 40.1 eV and qualitative results for the 2^1S, 2^3S and 2^3P states which are superior to previous calculations. (Diss. Abstr. Int., B)

13757 KINEMATIC STUDIES OF CHARGE TRANSFER IN COLLISIONS BETWEEN RARE GAS IONS AND DIATOMIC MOLECULES. Budzynski, T. L. Gainesville, FL; Univ. of Florida (1973). 111p. University Microfilms Order No. 74-10,027.

Thesis (Ph. D.).

Charge transfer reactions in the collisions of Ar^+, Ne^+, and Kr^+ with H_2, D_2, O_2, NO, N_2, and CO_2 were studied at scattering angles near 90° with incident ion energies from 30 to 373 eV. Also, dissociative charge transfer reactions in collisions of Ar^+ with H_2, and D_2 and Ne^+ with O_2 were studied at 90° with incident ion energy of 123 eV. The experiments measure the kinetic energy distribution of the product ions and use kinematical considerations to determine the energy defects of the reactions. In addition, the total current produced by near-resonant reaction channels was measured at angles about 90° for the charge transfer reactions of Ar^+ in CO_2 and O_2. Because the experimental method involved gas-scattering, it was necessary to determine the effect of the thermal motion of the target molecules upon the measured energy distributions. A calculational procedure was developed to estimate this effect; results of calculations made for the reactions of this investigation are reported. The experimental findings show the predominant exothermic reaction channel at 90° to the near-resonant for all charge transfer reactions. The angular distributions of the product ion current show the center-of-mass cross sections to be sharply peaked at angles near 180° corresponding to scattering at large impact parameters with little deviation from the incident trajectories. The measurements of dissociative charge transfer show the reaction $Ne^+ + O_2 = Ne + O^+ + O$ to proceed at the measured incident ion energy via the formation of $O_2^+(b^4\Sigma)$. The dissociative charge transfer reactions of Ar^+ in H_2 and D_2 show considerably greater internal energy given to the H_2^+ before dissociation than to D_2^+. (Diss. Abstr. Int., B)

13758 INTERMOLECULAR POTENTIALS BY THE INVERSION OF MOLECULAR BEAM SCATTERING DATA. IV. DIFFERENTIAL CROSS SECTIONS AND POTENTIAL FOR LiHg. Buck, U.; Hoppe, H.O.; Huisken, F.; Pauly, H. (Max-Planck-Institut für Strömungsforschung, Göttingen, Germany). J. Chem. Phys. 60: No. 12, 4925-4929 (15 June 1974).

High resolution differential scattering cross sections of lithium atoms by mercury have been measured in the thermal energy range. Supernumerary rainbows and rapid oscillations were well resolved. The data have been inverted to the interaction potential by the procedure described in Paper I [J. Chem. Phys. 54, 1923 (1971)]. The resulting potential (potential well depth $\epsilon = 16.9 \times 10^{-14}$ erg and distance $r_m = 3.00$ Å at the minimum) differs significantly in both the shape and the size parameters from the other alkali–mercury systems. (auth)

13759 RELATIVE VIBRATIONAL INTENSITIES FOR THE $B^1\Sigma^+ - X^1\Sigma^+$ TRANSITION IN CARBON MONOXIDE. Klump, K.N.; Lassettre, E.N. (Center for Special Studies and the Department of Chemistry, Mellon Institute of Science, Carnegie-Mellon University, Pittsburgh, Pennsylvania 15213). J. Chem. Phys. 60: No. 12, 4830-4832 (15 June 1974).

In the electron impact spectrum of carbon monoxide two vibrational peaks ($v'=0$, 1) are found in excitation of the $B^1\Sigma^+$ state. (Higher vibrational states are predissociated.) According to the Franck–Condon principle, relative intensities of vibrational progressions in a single electronic transition should not change with scattering angle and this has been verified, in past research, for many such progressions. However, the intensity ratio for the two peaks, associated with the $B^1\Sigma^+$ state, changes markedly with angle. For example, with incident electrons of 400 eV energy the ratio changes by a factor of ten in passing from a scattering angle of 0 to 20°. This is the typical behavior of excitations associated with different electronic transitions. Conceivably, strong interaction of two electronic states (due to breakdown of the Born–Oppenheimer approximation) could be involved. If we accept the assignment of the two peaks as due to transitions to the $v'=0$ and $v'=1$ vibrational levels of $B^1\Sigma^+$ (as spectroscopists do) then breakdown of the Born–Oppenheimer approximation is the only acceptable alternative. (auth)

13760 SEMICLASSICAL THEORY OF COLLISIONALLY INDUCED FINE-STRUCTURE TRANSITIONS IN FLUORINE ATOMS. Preston, R.K.; Sloane, C.; Miller, W.H. (Department of Chemistry, and Inorganic Materials Research Division, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). J. Chem. Phys. 60: No. 12, 4961-4969 (15 June 1974).

A calculation of fine-structure transitions in F atoms impinging on both Xe and H^+ has been carried out using a novel semiclassical theory that was proposed recently by Miller and George. The theory has the advantage of being conceptually simple and applicable to a wide class of situations. For Xe+F the cross section for the $^2P_{3/2} \rightarrow {}^2P_{1/2}$ excitation of F rises from its threshold (0.05 eV) to a value of ~0.1 Å² at a collision energy of 0.5 eV. The cross section for $H^+ + F$ is much larger, reaching a value of ~1 Å² at a collision energy of 0.25 eV, in reasonable agreement with recent quantum mechanical calculations. (auth)

13761 APPLICATION OF THE VARIATIONAL LEAST SQUARES METHOD TO INELASTIC SCATTERING. Abdallah, J. Jr.; Truhlar, D.G. (Department of Chemistry, University of Minnesota, Minneapolis, Minnesota 55455). J. Chem. Phys. 60: No. 12, 4670-4675 (15 June 1974).

The anomaly-free, minimum-norm, and variational least squares methods for algebraic variational inelastic quantum mechanical scattering calculations are all applied to the same example. The zero-order variational least squares method, which is completely free of spurious singularities, is found to be an accurate and useful method. Some alternative versions of the variational least squares method are pointed out. (auth)

13762 SOME ASPECTS OF THE QUENCHING OF RADIATION FROM ATOMS BY COLLISION WITH MOLECULES. Pan, R. Y. W. New Haven, CT; Yale Univ. (1973). 219p. University Microfilms Order No. 74-11,625.

Thesis (Ph. D.).

The quenching of electronically excited atoms by molecules at thermal energies, an example of electronic-vibrational energy transfer, is investigated using a model involving an ionic intermediate state proposed first by Magee and Ri. The process is $A^* + BC \rightarrow A^+ + BC^- \rightarrow A + BC^\ddagger$ where * denotes electronic excitation, ‡ denotes vibrational excitation, A denotes any atom,

and BC denotes any diatomic molecule. Previous calculations on the probability of charge transfer $A^+ + BC \rightarrow A^+ + BC^-$ by Bauer, Fisher, and Gilmore were based on the assumption of the incoherence of amplitudes generated at the crossing of the energies of vibrational states in the two configurations. This assumption is analyzed and found to be unjustified in general. An alternative calculation of the probability of charge transfer is presented to avoid such an approximation. The electronic Hamiltonian is diagonalized to yield adiabatic states; transitions between these states, which are induced by the relative motion of the atom and the molecule and by the molecular vibrations, are calculated by perturbation theory; they are found to be negligible for typical values of all the relevant parameters. It follows that the transition $A^+ + BC \rightarrow A^+ + BC^-$ in collisions at thermal energies occurs with nearly 100% probability; arguments are given that this transition should be followed by quenching. The model is then used to calculate the total quenching cross sections of Na(3P) by N_2 and H_2. It is found that because of differences in the symmetry of the ionic states, the quenching by H_2 should be less efficient than the N_2. The calculated cross sections are in fair agreement with the experimental cross sections at flame temperatures. Experiments on Na-N_2 and Na-H_2 have indicated that there is a rise of a factor of about 2 in the total quenching cross sections at room temperatures compared to the cross sections at flame temperatures. With the inclusion in the calculations of long range Van der Waals interactions in the initial state, reasonable agreement in the energy dependence of the quenching cross sections of Na(3P) by N_2 and H_2 is obtained. Finally, an observed correlation between having a low-lying shape resonance and efficient quenching is discussed. (Diss. Abstr. Int., B)

13763 CHEMIIONIZATION OF O_2 MOLECULES BY HELIUM METASTABLE ATOMS. West, W.P.; Cook, T.B.; Dunning, F.B.; Rundel, R.D.; Stebbings, R.F. (Department of Space Physics and Astronomy, Rice University, Houston, Texas 77001). J. Chem. Phys. 60: No. 12, 5126-5127 (15 June 1974).

Chemiionization of O_2 by He(2^1S) and He(2^3S) metastable atoms has been studied using a crossed beams apparatus. Branching ratios for the production of O_2^+, O^+, and O^- have been measured. The results are compared with those of other experiments. (AIP)

13764 SCATTERING OF ALKALI HALIDES BY ELECTRONS. I. CsF. Slater, R.C.; Fickes, M.G.; Becker, W.G.; Stern, R.C. (Department of Chemistry, Columbia University, New York, New York 10027). J. Chem. Phys. 60: No. 12, 4697-4709 (15 June 1974).

The scattering of CsF by 0.69-6.81 eV electrons has been measured with the molecular beam recoil technique. A novel kinematic analysis is used to fit center of mass differential cross section models to the data. Absolute total cross sections determined in this fashion are a factor of 2 smaller than first Born approximation predictions at low energies. Absolute momentum transfer cross sections are an order of magnitude smaller than theory. (auth)

13765 KINEMATICS OF SMALL ANGLE SCATTERING. Fickes, M.G.; Stern, R.C. (Department of Chemistry, Columbia University, New York, New York 10027). J. Chem. Phys. 60: No. 12, 4710-4718 (15 June 1974).

In beam-recoil measurements of the scattering of molecules by electrons or photons, deflected molecules are observed at very small angles, comparable to the angular divergences of the observed and crossing beams. A kinematic analysis is presented that explicitly includes the effects of these divergences. Distinguishing features of the analysis include the transformation to apparatus fixed vs "laboratory" coordinates and the calculation of the integrals over a finite detector in center of mass coordinates. The latter feature permits a simple recipe for inversion of laboratory observations to obtain a center of mass differential cross section. (auth)

13766 QUANTUM MECHANICAL SCATTERING OF ASYMMETRIC MOLECULES. III. CALCULATIONS OR TOTAL MOLECULAR BEAM CROSS SECTIONS FOR THE SYSTEMS He-D_2 AND He-HT. Heukels, W.F.; van Montfort, J.T.; van de Ree, J. (University of Technology, Eindhoven, The Netherlands). J. Chem. Phys. 60: No. 12, 4939-4949 (15 June 1974).

Exact quantum mechanical coupled channels calculations including closed channels have been performed for the systems He-D_2 as an example of an interaction potential with electronic anisotropy, and for the system He-HT in order to compare for the effect of the shift of the center of interaction from the center of mass. Total integrated collision cross sections have been evaluated for an energy range which is experimentally accessible. The effects of elastic and inelastic rotational contributions necessitate a reconsideration of the law of conservation of cross section. Feshbach resonances, undulating structures due to metastable orbiting resonances, and Newton-Fonda anomalies at thresholds for rotational excitation are discussed. The magnitude of the deviations for asymmetric molecules in different rotational states forbid the use of the customary approximation calculations. These deviations will be responsible for systematic errors in experiments if one tries to analyze the data with spherical symmetric potentials. The influence of the source temperature is mentioned. The determination of the ratio of polarized beam cross sections yields interesting results about alignment of spins. Whereas the determination of the repulsive anisotropy in the high energy limit appears to be possible within 20% error with the shift approximation, the attractive anisotropy is only accessible with exact coupled channels calculations because of the presence of metastable orbiting influence in the intermediate energe range. (auth)

13767 MEASUREMENT OF DIFFERENTIAL ATOMIC COLLISION CROSS SECTIONS—THE INFLUENCE OF APPARATUS GEOMETRY. Sauers, I.; Thomas, E.W. (School of Physics, Georgia Institute of Technology, Atlanta, Georgia 30332). Rev. Sci. Instrum. 45: No. 6, 809-813 (June 1974).

We examine certain problems that are inherent in the measurement of cross sections for small angle scattering of atomic projectiles in a gas target. It is shown that the use of rectangular apertures to select the scattered particles will inevitably distort the measurements so that they are not representative of the true cross section. Finite aperture height must be considered in the derivation of the geometrical collection efficiency exhibited by any pair of rectangular apertures. This height also causes distortion so that the measured cross section does, in general, lie below the true value. It is suggested that experiment and theory may best be compared by convoluting the theoretical predictions into the experimental geometry. A previous publication of the cross section for scattering of 10 keV H^+ in helium indicated that a theoretical prediction, using a "static potential," was not in agreement with experiment at low scattering angles. A reassessment of these data has been made and the theoretical prediction is convoluted into the experimental geometry. Theory and experiment are now found to be in complete agreement. (auth)

13768 MULTI-IONIZATION OF NEON, ARGON, AND XENON AND THEIR IONS BY HIGH-ENERGY-ELECTRON IMPACT. Salop, A. (Lawrence Berkeley Laboratory, University of California, Berkeley, California). Phys. Rev. A 9: No. 6, 2496-2504 (June 1974).

Estimates have been made of the total ionization cross sections for the collision of high-energy electrons with neon, argon, and xenon atoms and all of their ground-state ions. The cross sections were computed within the framework of the Bethe-Born high-energy-approximation theory using the semiclassical projection-operator technique of Hahn and Watson and the independent-particle model for atoms of Green, Sellin, and Zachor. Both direct continuum ionization and inner-shell excitation followed by Auger transitions were taken into account. Multiple-ionization cross sections were also estimated using experimental data on electron emission following ejection of inner-shell electrons in the various rare-gas atoms and a simplified model of Auger-vacancy cascading in ions. The computed cross-section values were then used in calculations of the cumulative ionization produced by a relativistic electron-ring beam interacting initially with pressure pulses of the various gases. The results obtained, taken together with previous computations for krypton, indicate a progressive increase in the relative importance of Auger processes with increase in Z such that for xenon (and presumably for higher-Z target atoms) Auger ionization dominates the production rates of most of the multicharged ions formed in such a system. (auth)

13769 PROJECTILE CHARGE-STATE DEPENDENCE OF Ne K-SHELL IONIZATION AND FLUORESCENCE YIELD IN 50-MeV Cl^{n+} + Ne COLLISIONS. Burch, D.; Stolterfoht, N.; Schneider, D.; Wieman, H.; Risley, J.S. (Department of Physics, University of Washington, Seattle, Washington 98195). Phys. Rev. Lett. 32: No. 21, 1151-1154 (27 May 1974).

Ne K x-ray and Auger-electron production cross sections have been measured in 50-MeV Cl + Ne collisions for incident charge states of 5+ to 15+. The ionization cross section and mean fluorescence yield were derived from the data. A factor 20 rise in the x-ray cross section over the charge-state range studied is primarily due to a factor 7.2 increase in the mean fluorescence yield. The factor 2.8 rise in the ionization cross section can be explained by a decreased screening of the projectile nuclear charge. (auth)

13770 X-RAY PRODUCTION BY 1.5-11 MeV PROTONS. Akselsson, R.; Johansson, T. B. (Univ. of Lund, Sweden). Z. Phys.; 266: No. 4, 245-255(Feb 1974).

K-shell ionization and L x-ray production cross sections by proton impact were determined from measurements of K x-ray yields from thin targets of Ti, Fe, Co, Cu, Ni and Ag and of L x-ray yields from Au and Pb. The proton energies varied from 1.5 to 11 MeV. The total error in the measured cross sections is mostly less than 5%. K_β/K_α ratios and $L_{1,\beta_{1,3}}/L_\alpha$ ratios were determined. Ionization cross sections were compared with predictions of the plane-wave Born approximation (PWBA) and the binary-encounter approximation (BEA). An empirical formula for ionization cross sections is derived. (GE)

13771 DIFFRACTION EFFECT IN THE ELASTIC SCATTERING OF ION BEAMS AT ATOMS. Beier, H. J. (Technische Univ., Berlin). Z. Phys.; 267: No. 1, 49-53(Mar 1974). (In German).

For the elastic scattering of ion beams at atoms the diffraction of the matter wave at the atom can be observed in the region of small scattering angles and high energies. The diffraction causes undulations in the differential scattering cross section. A general solution of the diffraction effect is given. The solution is valid for the Yukawa type screened Coulomb potential which is well suited for the small angle scattering of ions on atoms and which contains two parameters. The computations were made using the partial wave method and the Jeffreys-Born-approximation for the scattering phase shifts. The solution is presented in a form in which the amplitudes and characteristic constants of the first four undulation maxima and minima are given in dependence of a product which contains one of the potential parameters. The characteristic constants are correlated in a characteristic equation with the second potential parameter and the positions of the diffraction extrema. The conditions for the appearance of the diffraction effect are discussed. (GE)

13772 DETERMINATION OF POTENTIAL PARAMETERS FOR THE INTERACTION OF IONS AND ATOMS FROM THE DIFFRACTION EFF. Beier, H. J. (Technische Univ., Berlin). Z. Phys.; 267: No. 1, 55-59(Mar 1974). (In German).

The determination of the potential parameters from experimental results is considered. The potential parameters are determined from the amplitudes and the positions of the experimental diffraction pattern by applying the general solution of the diffraction effect derived in a previous paper. All existing experimental results up-to-date are referred to and evaluated. For the following scattering systems the potential parameters were determined and are presented in a table: $^7Li^+ - He$, $^7Li^+ - Ne$, $^7Li^+ - Ar$, $^7Li^+ - Kr$, $^7Li^+ - Xe$, $^6Li^+ - Ar$, and $H^+ - Ar$. (GE)

Atomic Theory

Refer also to abstract 13685.

13773 VARIATIONAL PERTURBATION THEORY INVESTIGATIONS ON TWO-ELECTRON ATOMIC SYSTEMS. III. NONRELATIVISTIC RESULTS FOR THE STATE 1s2s ^3S. Aashamar, K.; Midtdal, J. (Institute of Physics, University of Oslo, Norway); Lyslo, G. J. Chem. Phys. 60: No. 9, 3403-3411(1 May 1974).

The variational perturbation (HSK) procedure has been applied to the two-electron atomic state 1s2s ^3S. The total nonrelativistic energies and corresponding wavefunctions have been determined with errors less than one part in 10^{12} and 1-2 parts in 10^8, respectively, for all $Z \geq 2$. The results are presented in tables accompanied by illustrative figures. (auth)

13774 NUCLEAR QUADRUPOLE RESONANCE. Lucken, E. A. C. (Geneva Univ. (Switzerland)). J. Mol. Struct.; 19: No. 1, 43-57(Dec 1973).

From international conference on Molecular Spectroscopy; Wroclaw, Poland (15 Sep 1972).

The study of nuclear quadrupole resonance spectroscopy can conveniently be divided into two sections. The first is concerned with the nuclear quadrupole coupling constants themselves and their relation to the electronic structure of the corresponding molecules, while the second is concerned with the effects of environment and motion on the quadrupole coupling constants and the relaxation times. The paper is mainly concerned with the first of these two aspects and mention is made of coupling constants measured by techniques other than that of pure quadrupole resonance; the second aspect of quadrupole resonance has so far been much less studied but it is undoubtedly the one which will be of most interest in the years to come and the last part of the paper is devoted to this. (auth)

13775 COMMENT ON TWO-PHOTON EMISSION OF x RAYS. Eichler, J. (Hahn-Meitner-Institut für Kernforschung Berlin Bereich Kern- und Strahlenphysik, Berlin, West Germany). Phys. Rev. A 9: No. 4, 1762-1764 (Apr 1974).

The structure of the second-order matrix element describing two-photon emission of x rays is discussed. The point of departure is the gauge invariance of a general Hamiltonian in the formulation by Sachs and Austern. (auth)

13776 THEORY OF AUGER-SATELLITE ENERGY SHIFTS. Shirley, D.A. (Department of Chemistry and Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). Phys. Rev. A 9: No. 4, 1549-1554 (Apr 1974).

A theoretical model is described for calculating energy shifts of Auger satellites—Auger transitions that occur in the presence of "spectator" vacancies. The shifts arise through a combination of direct and indirect (or relaxation) interactions between spectator and regular hole states. Both can be expressed in terms of two-electron Coulomb and exchange integrals, and approximate pairwise additivity of the shifts due to holes or spectator vacancies is demonstrated. An approximate method, based on the "equivalent-cores" approximation, is employed to estimate numerical values of the indirect term using only tabulated two-electron integrals for atomic ground states. Satellite shifts for the $L_3M_{45}M_{45}$ (M_{45}) transition are thereby estimated for elements with $70 \leq Z \leq 100$. The predicted value of -38 eV for bismuth is in excellent agreement with the experimental value -36 ± 5 eV reported for ^{210}Bi by Haynes, Velinsky, and Velinsky. For americium the predicted value is -61 eV; Freedman and Porter reported an experimental value -56 eV. Other predicted satellite shifts in bismuth also show reasonably good agreement with less-accurate experimental values. These results thus strongly support previous interpretations of satellite shifts and appear to provide a fairly accurate and very easy method for predicting these shifts in deep core levels. (auth)

13777 METHOD OF SUCCESSIVE APPROXIMATIONS FOR MANY-ELECTRON WAVE FUNCTIONS. Kansa, E.J. (Vanderbilt University, Nashville, Tennessee 37203). Phys. Rev. A 9: No. 4, 1555-1563 (Apr 1974).

Assuming that there exists a correspondence between the methods of the superposition of configurations and linked-cluster perturbation-theory expansions, a method of successive approximations was used to generate the coefficients of the superposition of configuration expansion and the correlation energy of a many-electron wave function. The algorithm was applied to the ground state of Be. Using an excited s,p,d orbital basis set calculated in the V^N potential, and estimating the truncation error of the remaining pair-correlation energies of the partial-wave expansion, a correlation energy of -0.09312 a.u. was obtained. (auth)

13778 SELF-CONSISTENT ANALYTIC POTENTIAL FOR ATOMS. Yunta, J.; Máyquez, E.R.; Sánchez del Río, C. (Junta de Energía Nuclear, Madrid-3, Spain). Phys. Rev. A 9: No. 4, 1483-1485 (Apr 1974)

An expedient self-consistency scheme for the determination of parameters of atomic analytic potentials is presented. The method is applied to a simplified one-parameter potential. Values of the parameter for the ground configuration of all atoms are given. Rules to estimate the parameter for excited configurations and ions are also provided. (auth)

13779 DICKE SUPERRADIANCE FROM ATOMIC SYSTEMS WITH DIPOLAR COUPLING. De Martin, F. (Univ., Rome). Lett. Nuovo Cim.; 10: No. 7, 275-280(15 Jun 1974).

A perturbative solution of the problem of the super-radiant spontaneous emission from an ensemble of interacting two-level atomic systems via the dipolar forces acting among the dipoles of the medium is given. (JFP)

13780 ATOMIC RADIAL INTEGRALS AND A USE OF O(2, 1) TRANSFORMATION. Kumei, S. (Physics Department, University of the Pacific, Stockton, California 95204). Phys. Rev. A 9: No. 6, 2306-2311 (June 1974).

We study the finite transformation of the O(2, 1) group associated with hydrogenic radial functions, and with its aid we evaluate atomic integrals

$$\int_0^\infty R_{n_1}(a_m r) R_{n_2}(a_n r) r^{\nu-1} e^{-ikr} r^2 dr, \quad \mathrm{Re}(ik + \tfrac{1}{2}a_m + \tfrac{1}{2}a_n) > 0,$$

$$\int_0^\infty [R_{n_1}(a_n r)]^2 r^{\nu-1} \sin(kr) r^2 dr, \quad \int_0^\infty [R_{n_1}(a_n r)]^2 r^{\nu-1} \cos(kr) r^2 dr,$$

$$\int_0^\infty R_{m_1}(a_m r) R_{n_1}(a_n r) r^2 dr, \quad \int_0^\infty R_{n_1}(a_m r) T R_{n_2}(a_n r) r^2 dr,$$

where the functions $R_{n_1}(a_n r)$ are the hydrogenic radial functions, and the operator T represents the kinetic energy. The scale a_m for each function can be chosen arbitrarily. Using some of these results, we obtain the two-particle radial integrals

$$\int_0^\infty [R_{n_1 l_1}(ar_1)]^2 (r_1 r_2)^{-1} \delta(r_1 - r_2) [R_{n_2 l_2}(ar_2)]^2 r_1^{\frac{1}{2}} r_2^{\frac{1}{2}} dr_1 dr_2,$$

$$\int_0^\infty [R_{n_2 l_2}(ar_1)]^2 (r_>)^{-1} [R_{n_2 l_2}(ar_2)]^2 r_1^{\frac{1}{2}} r_2^{\frac{1}{2}} dr_1 dr_2. \text{ (auth)}$$

13781 MULTICHANNEL CONFIGURATION-INTERACTION THEORY: APPLICATION TO SOME RESONANCES IN HELIUM. Ramaker, D.E. (Department of Chemistry, University of Minnesota, Minneapolis, Minnesota 55455); Schrader, D.M. Phys. Rev. A 9: No. 5, 1980-1991 (May 1974).

Using the method of configuration interaction as applied to autoionization by Fano, expressions involving the reaction matrix $\underline{K}$ in the basis of the original configurations are given for the width and resonance energy. The expression obtained for the width is a Fermi "golden rule" type formula similar to that proposed by Miller. The expression for the resonance energy changes only slightly as the independent energy parameter varies, and therefore it is possible to consider a particular resonance among closely spaced resonances without elaborate search procedures. Application is made to the (nl^2) ^1S autoionizing states of He below the $n = 4$ threshold. No significant near-neighbor resonance interactions were found despite the small energy intervals between adjacent levels. The results indicate the $5s^2$ state falls

below the n = 4 threshold, which is reflected in the small width given by our results. Widths, resonance energies, relative decay probabilities for each of the open channels, and Fano–Cooper cross-section parameters are given for all the states considered. Comparison is made with experiment and other theories where possible. (auth)

13782 COMMENT ON THE HARTREE–FOCK THEORY FOR HYPERFINE INTERACTIONS. Mahanti, S.D. (Department of Physics, Michigan State University, East Lansing, Michigan 48823); Das, T.P.; Lee, T.; Ikenberry, D. Phys. Rev. A 9: No. 5, 2238-2241 (May 1974).

Recently Amoruso and Johnson (AJ), using a relativistic formulation, have pointed out that earlier theories of exchange-polarization effects on hyperfine constants in atoms had omitted an important contribution. This contribution would have serious implications for a number of solid-state hyperfine calculations. We show that in a correct Hartree–Fock formulation, the contribution proposed by AJ vanishes exactly, a conclusion that is also substantiated by results of recent many-body perturbation-theory calculations. The need for a reevaluation of relativistic effects on exchange core polarization in Hartree–Fock theory is emphasized. (auth)

13783 INDEPENDENT-PARTICLE-MODEL POTENTIALS FOR IONS AND NEUTRAL ATOMS WITH $Z \leq 18$. Szydlik, P.P.; Green, A.E.S. (Department of Physics and Astronomy, University of Florida, Gainesville, Florida 32611). Phys. Rev. A 9: No. 5, 1885-1894 (May 1974).

The atomic independent-particle model of Green, Sellin, and Zachor (GSZ) is used to obtain potentials for electrons in ions of light elements ($Z \leq 18$). The two parameters of such potentials are obtained by the ab initio procedure of Bass, Green, and Wood (BGW). Here the expectation of the exact Hamiltonian with respect to a Slater determinant of one-electron wave functions corresponding to GSZ potentials is minimized. Total energies determined by this modified Hartree–Fock procedure are found to be in excellent agreement with Hartree–Fock values (usually within a hundred parts per million). Potential parameters obtained in this way are found to be strongly dependent on both the atomic number and the number of electrons in the ion. Several other simple analytic potentials are treated in a similar way and it is found that the two-parameter GSZ and Gaspar potentials yield energies substantially lower than one-parameter potentials of the forms used earlier by Bohr and Tietz. (auth)

13784 ATOMIC AND MOLECULAR ELECTRONIC SPECTRA AND PROPERTIES FROM THE ELECTRON PROPAGATOR. Purvis, G.D.; Öhrn, Y. (Quantum Theory Project, Department of Chemistry, University of Florida, Gainesville, Florida 32601). J. Chem. Phys. 60: No. 10, 4063-4069 (15 May 1974).

Decoupling in terms of the superoperator formalism according to Pickup and Goscinski is employed to find tractable forms of the self-energy operator leading to direct calculation of the electron propagator or Green's function. This is applied to the calculation of photoelectron line spectra, ground state total energies, and electronic properties of atoms and molecules. Numerical results for the helium atom and the nitrogen molecule are reported. (auth)

13785 RADIATION EMISSION BY AN ATOM IN AN EXTERNAL ELECTROMAGNETIC FIELD. Kazantsev, A. P. (Inst. of Theoretical Physics, Moscow). Zh. Eksp. Teor. Fiz.; 66: No. 4, 1229-1236(Apr 1974). (In Russian).

Emission by an atom in an external field is considered for an arbitrary relation between the field amplitude and level widths. Only the resonance approximation is employed. The emission spectrum is determined from a set of kinetic equations for the atomic density matrix and correlation matrix. The case of a monochromatic external field is considered in detail. The emission spectrum is split into a coherent and non-coherent part. The transition to the case of rapidly decaying levels, when the one-photon approximation is valid, is considered. Transition to the case of a stationary lower level (resonance fluorescence) is also considered. (auth)

13786 ONE-PARAMETER TEN HOOR TYPE FUNCTION FOR THE INDEPENDENT PARTICLE MODEL OF A TWO-ELECTRON ATOMIC SYSTEM IN ITS GROUND STATE. Pellegatti, A. (Laboratoire de chimie Théorique, Université de Provence, Place Victor Hugo, 13331 Marseille cedex 3, France). J. Chem. Phys. 60: No. 12, 5136-5137 (15 June 1974).

M. J. Ten Hoor [J. Quantum Chem. 2, 109 (1968)] has suggested a two-parameter trial function for a two-electron atomic system. A relationship is given between the two parameters that produces a one-parameter function. Energy minimizations are carried out in order to compare the two functions. (AIP)

PHYSICS (ELECTROFLUID AND MAGNETOFLUID)

13787 (AD-737124) DISCONTINUOUS MAGNETOFLUIDYNAMIC FLOWS. Final Scientific Report. Geffen, N.; Libai, S. (Tel Aviv Univ. (Israel)). Jun 1971. Contract F61052-70-C-0026. 38p. (AFOSR-TR-72-307). NTIS $3.00.

Numerical analysis and results of computer simulation for the nonlinear axial flow of a free surface liquid conductor under the influence of a time-varying magnetic field are presented. The analysis is applicable to other physical systems, which can be described as initial value problems for a system of first-order quasi-linear, partial differential equations, possibly non-homogeneous with forcing and friction terms. Results are given for calculations on a fixed mesh by a Lax–Wendroff scheme, including a shock formation, propagation and reflection from the axis of symmetry; also integration along characteristics, for the continuous part of the field until a shock starts to form. In addition, a semi-analytic solution is worked out for the initial characteristic triangle, and its break-down point is estimated. Comparison among results obtained by the different methods is given, and application to configurations of plasma-confinement, astrophysical atmospheric and oceanographic problems pointed out. (auth)

13788 SUPER-ALFVÉNIC FLOW AND COLLISION FREE SHOCK WAVE IN A PLASMA WIND TUNNEL. Kuriki, K.; Inutake, M. (Institute of Space and Aeronautical Science, University of Tokyo, Komaba, Meguro-ku, Tokyo, Japan). Phys. Fluids 17: No. 1, 92-99 (Jan 1974).

A super-Alfvénic and supersonic flow in a plasma wind tunnel were studied experimentally. The wind tunnel was constructed for the studies of the magnetohydrodynamic shock waves and wakes, and has features such as quasisteady flow and low fluctuation level. The Alfvén Mach number M_A and ion acoustic Mach number M covered in the present experiment are $M_A = 1$–4 and $M = 2$–6. A standing shock wave was found downstream of the magnetic-nozzle exit. The shock wave is collision free and the normal of the wavefront is parallel to the magnetic field. Macroscopic features of the shock wave were discussed with reference to the theoretical predictions of the magnetohydrodynamic and collision-free shock waves. (auth)

13789 MODIFIED KORTEWEG–DE VRIES EQUATION IN ELECTROHYDRODYNAMICS. Perel'man, T. L.; Fridman, A. Kh.; El'yashevich, M. M. (Inst. of Heat and Mass Exchange, Minsk). Zh. Eksp. Teor. Fiz.; 66: No. 4, 1316-1323(Apr 1974). (In Russian).

Waves on a free surface of an ideally conducting fluid in the presence of a transverse electric field are investigated within the framework of the modified Korteweg–de Vries (KDV) equation. It is shown that the solution is a two-parameter soliton family and a shock wave family. A qualitative investigation of the time evolution of the modified KDV equation is carried out for local initial distributions and it is shown that cubic nonlinearity results in the formation of shock waves and impedes soliton formation. The problem of soliton scattering by a shock wave is solved exactly. A one parameter soliton family for the KDV equation is found by means of the nonlinear Miura transformation.

PHYSICS (HIGH-ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstracts 13857–13861 and 13954.

Electromagnetic

Refer also to abstracts 13326, 13873, and 14181.

13790 (DESY-73-66, pp 121-172) EXPERIMENTS WITH e^+-e^- COLLIDING BEAMS. Conversi, M. (Univ., Rome). Dec 1973.

From proceedings of the seminar on e–p and e–e storage rings; Hamburg, Germany (8 Oct 1973).

Recent results on e^+e^- colliding beams at ADONE are reported. Tests of quantum electrodynamics, limits to mass and coupling of possible particles, processes involving more photons, detailed investigations on the properties of the vector mesons ρ, ω, and ϕ, new vector mesons, pion and kaon form factors in the time-like region, multihadron production, new tests of quantum electrodynamics, limits to possible particles, and photon–photon interactions, are discussed. (JFP)

13791 (DESY-73-66, pp 173-216) IDEAS ON PHYSICS WITH EPIC. Manning, G. (Rutherford High Energy Lab., Chilton, Eng.). Dec 1973.

From proceedings of the seminar on e–p and e–e storage rings; Hamburg, Germany (8 Oct 1973).

The discussion covers the electron–proton and electron–positron intersecting complexes, the working parties that have been meeting during 1973, some of the physics that can be covered using e^+e^- and ep machines, some conclusions reached during a recent study week, and a brief indication of possible future plans. (JFP)

13792 (DESY-73-66, pp 217-268) INELASTIC ELECTRON SCATTERING AT 12 + 80 GeV. Lohrmann, E.; Wiik, B. H.; Wolf, G. Dec 1973.

From proceedings of the seminar on e–p and e–e storage rings; Hamburg, Germany (8 Oct 1973).

The discussion of inelastic electron scattering experiment preparation covers kinematics, total inelastic ep cross sections, the pion background, the kinematics of peripheral reactions, inclusive pion spectra, vector meson production in ep interactions, and the kinematics for ep colliding beams. (JFP)

13793 (COO-2114-11) TABLES OF EVENT RATES IN DEEP INELASTIC ELECTRON SCATTERING. Nauenberg, U. (Colorado Univ., Boulder (USA)). 1973. 14p. Dep. NTIS $4.00.

Tables indicating the number of events that can be detected per day for a particular value of $X = \nu$ are presented for deep inelastic electron scattering. These rates are given for various center of mass energies. (JFP)

13794 (JINR-E1-7275) STRUCTURE FUNCTIONS OF THE DEEP INELASTIC e-p SCATTERING. Bilen'kaya, S. I.; Bilen'kii, S. M.; Kazarinov, Yu. M.; Lapidus, L. I. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1973. 30p. INIS.

Worldwide data on deep inelastic e-p scattering are analyzed. Structure functions are described, and the parameters νW_2 and R are discussed. The field of scale invariance of νW_2 is established. Experimental data are shown to agree with different expressions for R. (tr-auth)

13795 COMPARISON OF THE DATA ON THE EAS HEIGHT BEHAVIOR AND ON THE INTENSITY OF CERENKOV RADIATION OF THE EAS PARTICLES. Antonov, R. A. (Inst. of Nuclear Physics, Moscow). Yadern. Fiz.; 19: No. 5, 1053-1058 (May 1974). (In Russian).

The values of the summed ionization losses of the EAS particles in the atmosphere higher than the level of observation are taken from the data on EAS height behavior and from the experimentally measured intensity of Cerenkov radiation of EAS particles and compared with each other. The same values are also compared with the evaluations made under various assumptions about the character of interaction of particles with $\sim 10^3$ TeV energies. (auth)

13796 SEARCH FOR FRACTIONALLY CHARGED PARTICLES PHOTOPRODUCED FROM COPPER. Galik, R.; Jordan, C.; Richter, B.; Seppi, E.; Siemann, R.H. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305); Ecklund, S.D. Phys. Rev. D 9: No. 7, 1856-1864 (1 Apr 1974).

A search for fractionally charged particles photoproduced from copper has been performed. No such events were detected. Lower limits for the mass of the quark established by this experiment are as follows: $m_{charge=1/3} > 3.6$ GeV/c^2 and $m_{2/3} > 4.5$ GeV/c^2, if the GeV/c^2, if the quark interacts strongly and if the Drell model of hadron photoproduction applies to quarks; $m_{1/3} > 1.4$ GeV/c^2 and $m_{2/3} > 1.8$ GeV/c^2, if the quark does not interact strongly ("leptonic" quark). (auth)

13797 FURTHER MEASUREMENTS OF FORWARD-CHARGED-PION ELECTROPRODUCTION AT LARGE k^2. Bebek, C.J.; Brown, C.N.; Herzlinger, M.; Holmes, S.; Lichtenstein, C.A.; Pipkin, F.M.; Sisterson, L.K. (Cyclotron Laboratory, Harvard University, Cambridge, Massachusetts 02138); Andrews, D.; Berkelman, K.; Cassel, D.G.; Hartill, D.L. Phys. Rev. D 9: No. 5, 1229-1242 (1 Mar 1974).

Measurements of the electroproduction reaction $e^- + p \rightarrow e^- + \pi^+ + n$ carried out at the Wilson Synchrotron Laboratory are reported. For fixed virtual photon–hadron center-of-mass energy, W = 2.67 GeV, data are presented with the mass of the virtual photon, $-k^2$, centered at 0.6, 1.2, and 2.0 (GeV)^2. At the central $-k^2 = 1.2$ (GeV)^2 point, results are also given for W = 2.15 GeV. For the W = 2.67, $-k^2 = 1.2$ (GeV)^2 setting, an angular scan is presented and the longitudinal transverse-interference term is extracted. The data are compared with an electric Born-model calculation of Berends which has as its only free parameter the pion electromagnetic form factor. The theory is used to extract new results for the pion form factor up to $-k^2 = 2.0$ GeV^2. (auth)

13798 DIFFERENTIAL CROSS SECTIONS OF $\pi^- p \rightarrow \gamma N$ FOR 317, 452, AND 491 MeV/c INCIDENT PION MOMENTUM. Berardo, P.A.; Haddock, P.P.; Nefkens, B.M.K.; Verhey, L.J.; Zeller, M.E. (University of California, Los Angeles, California); Parsons, A.S.L.; Truoel, P. Phys. Rev. D 9: No. 3, 621-643 (1 Feb 1974).

The differential cross sections of $\pi^- p \rightarrow \gamma n$ at center-of-mass energy $\bar{E} = 1363$, 1337, and 1245 MeV are presented. The angular distributions are compared with recent $\gamma n \rightarrow \pi^- p$ experiments. Though the cross sections for $\pi^- p \rightarrow \gamma n$ are somewhat lower than those for the inverse reaction, when all uncertainties are considered, we find that our data are in acceptable agreement at all three energies with the inverse reaction determined from π^-/π^+ ratio measurements, in support of time-reversal invariance. The agreement with bubble-chamber measurements at $\bar{E} = 1363$ and 1337 MeV is less satisfactory. The isotensor dip test applied to our data is inconclusive. Our measurements are compared with many multipole analyses, disagreeing with most, in particular with pure fixed-t dispersion relation calculations. We find no evidence, in the sense suggested by Donnachie, for the classification of the $P_{11}(1470)$ resonance in an SU(3) antidecuplet. The data are consistent with a small radiative decay of the $P_{11}(1470)$ resonance, as predicted by quark models. (auth)

13799 NEGATIVE-PION PHOTOPRODUCTION FROM NEUTRONS BY LINEARLY POLARIZED PHOTONS IN THE FIRST RESONANCE REGION. Kondo, K.; Miyachi, T.; Uksi, K.; Yamamoto, A.; Gotow, K.; Yoshida, H. (Institute for Nuclear Study, University of Tokyo, Tanashi-shi, Tokyo, Japan); Kurokawa, S.; Muramatsu, H.; Sasao, N.; Suzuki, S.; Kobayashi, M.; Iwata, S. Phys. Rev. D 9: No. 3, 529-533 (1 Feb 1974).

The angular dependence of the asymmetry for negative-pion photoproduction on neutrons by linearly polarized photons has been measured for photon energies 260, 300, 350, 400, 450, and 500 MeV at center-of-mass angles 60°, 75°, 90°, 150° and 120°. The results are compared with theoretical models of low-energy single-pion photoproduction. The observed asymmetry below 400 MeV shows good agreement with predictions of dispersion-theoretical models by Besrend, Donnachie, and Weaver and by Schwela. The asymmetry values in the 400–500 MeV energy region suggest that smaller M_1 amplitude is more favorable. (auth)

13800 π^0 AND ρ^0 PHOTOPRODUCTION FROM 6 TO 18 GeV. Barish, B.; Gomez, R.; Kreinick, D.; Peck, C.; Pine, J.; Sciulli, F.; Sherwood, B.; Tollestrup, A.; Young, K. (California Institute of Technology, Pasadena, California 91109). Phys. Rev. D 9: No. 3, 566-570 (1 Feb 1974).

Differential cross sections for π^0 and ρ^0 photoproduction from protons have been measured at photon energies 6, 12, and 18 GeV and momentum transfers 0.5 to 3 (GeV/c)^2. (auth)

13801 HOW FAST DOES THE NUCLEON–NUCLEON TOTAL CROSS SECTION RISE BEYOND ISR ENERGIES? Ganguli, S. N.; Subramanian, A. (Tata Inst. of Fundamental Research, Bombay). Lett. Nuovo Cim.; 10: No. 6, 235-241(8 Jun 1974).

It is shown that the growth of the total cross section is unlikely to be faster than ln s from ISR energies to extensive air shower energies. Evidence is presented based on previous EAS observations. (JFP)

13802 RADIATIVE WIDTH OF THE η MESON. Browman, A.; DeWire, J.; Gittelman, B.; Hanson, K.M.; Loh, E. (Laboratory of Nuclear Studies, Cornell University, Ithaca, New York 14850); Lewis, R. Phys. Rev. Lett. 32: No. 19, 1067-1070 (13 May 1974).

The cross section for the photoproduction of η mesons by the Primakoff process has been measured at bremsstrahlung energies of 5.8, 9.0, and 11.45 GeV. A value of 0.324 $\pm$ 0.046 keV was obtained for the partial width of the η meson decaying into photon pairs. This result is a factor of 3 lower than the previously accepted value. (auth)

13803 ELECTRON–PROTON COINCIDENCE MEASUREMENTS IN THE DEEP INELASTIC REGION. Brown, G. S. Ithaca, NY; Cornell University (3 Jul 1974). 148p. University Microfilms Order No. 74-7176.

Thesis (Ph. D.).

The reaction $e + p \rightarrow e + p + X^0$ was studied at the Cornell 12 GeV electron synchrotron. The four-momentum transfer to the electron, Q^2, spanned the range 0.4 to 2.2 GeV^2, and the proton-virtual photon center-of-mass energy spanned the range 4.8 to 16.0 GeV^2. The scattered electron and recoil proton were detected in coincidence, from which the four-momentum of the missing neutral boson was calculated. The differential and total cross sections, $d\sigma_{\rho\omega}/dt$, and $\sigma_{\rho\omega}$ for the rho + omega final states are reported. The cross section was parametrized by the form $d\sigma_{\rho\omega}/dt = A\exp(Bt)$, and it was observed that the slope parameter, B, decreases with Q^2 to a value $B = 4.0 \pm 0.4$ GeV^{-2} at $Q^2 = 1.3$. The total cross section was compared to a naive vector meson dominance prediction, and reasonable fits were obtained provided that the longitudinal-transverse parameter, ξ, is set to 0. Also the high mass cross sections, expressed differentially in m_x^2 or x, as well as in the form of an invariant cross section are reported.

13804 ELECTROMAGNETIC COUPLINGS OF HIGHER-MASS N^* RESONANCES. Knies, G. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720); Moorhouse, R.G.; Oberlack, H. Phys. Rev. D 9: No. 9, 2680-2684 (1 May 1974).

The previous partial-wave analysis of $\gamma N \rightarrow N\pi$ by Moorhouse, Oberlack, and Rosenfeld has been extended to 2000 MeV. (auth)

Weak

Refer also to abstract 13920.

13805 (DESY-73-66, pp 269-287) HOW TO DETECT WEAK INTERACTION PROCESSES AT e–p COLLIDING BEAM FACILITIES. Bartel, W.; Cords, D.; Felst, R.; Grindhammer, G. Dec 1973.

From proceedings of the seminar on e–p and e–e storage rings; Hamburg, Germany (8 Oct 1973).

The possibility of measuring the weak interaction process $e + p \rightarrow \nu$ (e) + anything at an e–p colliding beam facility is discussed. Counting rates, kinematics, and possible detector configurations are considered. (JFP)

13806 (JINR-P1-7925) EXPERIMENTAL STUDY OF THE K^0 $K_L^0 \rightarrow \pi^+\pi^-\pi^0$ DECAY MATRIX ELEMENT. Geshkov, I. M.; Markov, P. K.; Trayanov, R. K. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab of High Energy). 1974. 16p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

A sample of 32,000 $K_L^0 \rightarrow \pi^+\pi^-\pi^0$ decays recorded by an online spark chamber spectrometer in the K^0 beam of the Serpukhov accelerator was studied. The coefficient of the linear parametrization of the $K_L^0 \rightarrow \pi^+\pi^-\pi^0$ decay matrix element was found to be $a_1 = -0.280 \pm 0.014$. (auth)

13807 DIRECT $(\gamma\gamma)$ $(\bar{\nu}\nu)$ INTERACTION. Rekalo, A. P. (Physical Technical Inst., Kazan). Yadern. Fiz.; 19: No. 5, 1062-1070(May 1974). (In Russian).

Upper limits for coupling constant of the hypothetical $(\gamma\gamma)$ $(\bar{\nu}\nu)$ interaction between the neutrino and electromagnetic field are obtained using the data of the neutrino experiments. The neutrino luminosity of stars resulting from this interaction is compared with the neutrino luminosities due to the processes resulting from the $(\bar{\nu}\nu)$ $(\bar{\nu}e)$ interaction. It is shown that the reactions of the neutrino production in colliding lepton beams at high energies are most suitable to obtain a new upper limit for the $(\gamma\gamma)$ $(\bar{\nu}\nu)$ coupling constant. (auth)

13808 MEASUREMENT OF THE FORM FACTORS IN THE DECAY $K^+ \rightarrow \pi\mu\nu$. Arnold, C.L.; Roe, B.P.; Sinclair, D. (Physics Department, University of Michigan, Ann Arbor, Michigan 48104). Phys. Rev. D 9: No. 5, 1221-1229 (1 Mar 1974).

By studying K^+ stopping in a freon bubble chamber, we have measured the slopes of the vector and scalar form factors in the decay $K^+ \rightarrow \pi\mu\nu$ and find them to be $\lambda_+ = 0.025 \pm 0.03$, $\lambda_0 = -0.04 \pm 0.04$. This result is in good agreement with other experiments on $K^+_{\mu 3}$ decays, but not in agreement with the predictions of current algebra. It disagrees with the result of a recent high-statistics experiment on $K^0_{\mu 3}$ decays. (auth)

13809 SEARCH FOR EVIDENCE OF ANTINEUTRINO DECAYS. Morton, J.R. III; Richards, L.M. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). Phys. Rev. C 9: No. 4, 1668-1670 (Apr 1974).

An attempt was made to observe the decay of antineutrinos into a form of energy observable within a NaI crystal. Antineutrinos produced by fission in a nuclear device were incident on a 14-cm cube of NaI. No effect was observed, and minimum observable energy is given per fission. (auth)

13810 NEUTRINO MASS LIMITS FROM THE $K^0_L \rightarrow \pi^{\pm}l^{\mp}\nu$ DECAY SPECTRA. Clark, A.R.; Elioff, T.; Frisch, H.J.; Johnson, R.P.; Kerth, L.T.; Shen, G.; Wenzel, W.A. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). Phys. Rev. D 9: No. 3, 533-540 (1 Feb 1974).

A magnetic spectrometer at the Bevatron has been used to study the low-neutrino-energy ends of the $K_{\mu 3}$ and K_{e3} spectra. The spectra are found to agree well with the V–A predictions for massless neutrinos. The upper limits (90% confidence level) are 650 KeV for the muon-neutrino mass and 450 KeV for the electron-neutrino mass. (auth)

13811 EXPERIMENTAL STUDY OF THE ENERGY SPECTRUM OF THE π^+ In $K^+ \rightarrow \pi^+\pi^0\pi^0$ DECAY. Sheaff, M. C. Madison, WI; University of Wisconsin (1973). 45p. University Microfilms Order No. 74-21,144.

Thesis (Ph. D.).

A sample of 5635 π^+ with kinetic energies between 8 and 50 MeV was obtained from $K^+ \rightarrow \pi^+\pi^0\pi^0$ decays in the Michigan 40" H.L.B.C. filled with propane. It was found that the energy dependence was well described by a linear spectrum of the form: where $g = 0.602 \pm 0.021$. No compelling evidence was found for a quadratic term significantly different from 0. When the five conventional test quantities for the isospin selection rules were formed using the value of g from this experiment and the P.D.G. world averages for the other $K \rightarrow 3\pi$ decay parameters, it was found that there was significant evidence for $|\Delta I| = 3/2$ amplitudes into both I = 2 and I = 1 final states. Good agreement is found between these experimental values and theoretical predictions for them obtained in theoretical models which satisfy the current algebra relations at the soft pion points and include $|\Delta I| = 3/2$ as well as $|\Delta I| = 1/2$ amplitudes. (Diss. Abstr. Int., B)

13812 REGENERATION OF K^0 MESONS IN DEUTERIUM AND HYDROGEN AND THE CP VIOLATION. Loomis, W. A. Ithaca, NY; Cornell University (1973). 146p. University Microfilms Order No. 74-6315.

Thesis (Ph. D.).

K_S^0 mesons were regenerated from a beam of K_L^0 mesons striking targets of deuterium and hydrogen. The resultant $K_S^0 \rightarrow \pi^+\pi^-$ decays were detected by a pair spectrometer. The distribution of the $\pi^+\pi^-$ decays along the axis of the K_L^0 beam was analyzed to yield two results: the magnitude of the regeneration amplitude $4\pi/k\ f_{21}(0)$ in deuterium and hydrogen; the difference of the phases ϕ_{21} of $4\pi/k\ f_{21}(0)$ and ϕ_+ of η_+ the CP violating parameter. Using total cross section measurements and the optical theorem the imaginary part of the regeneration amplitude in deuterium is deduced and one can thus determine ϕ_+. The value $\phi_+ = 46.2^0 \pm 4.6^0$ is found in agreement with the "superweak" prediction. Results for the phase of the regeneration amplitude in hydrogen are also presented. (Diss. Abstr. Int., B)

13813 MEASUREMENT OF THE $\Sigma \rightarrow ne^-\bar{\nu}$ RATE AND SEARCH FOR $\Delta Q = -\Delta S$ TRANSITIONS IN $\Sigma^+ \rightarrow ne^+\nu$ DECAY. Ebenhoeh, H.; Eisele, F.; Engelmann, R.; Filthuth, H.; Hepp, V.; Leitner, E.; Thouw, T.; Zech, G. (Univ., Heidelberg). Z. Phys.; 266: No. 5, 367-368(Feb 1974).

In a bubble chamber experiment about 2×10^6 Σ^+-decays were measured to separate $\Sigma \rightarrow ne\nu$ events from the two-body modes. No $\Sigma^+ \rightarrow ne^+\nu$ event was found whereas 607 $\Sigma^- \rightarrow ne^-\nu$ decays could be identified. The data yield for the $\Delta Q = -\Delta S$ decay an upper limit: $\text{Gamma}(\Sigma^+ \rightarrow ne^+\nu)/\text{Gamma}(\Sigma^- \rightarrow ne^-\nu) < 1.9 \times 10^{-2}$ (90% confidence level) and the branching ratio: $\text{Gamma}(\Sigma^- \rightarrow ne^-\nu)/\text{Gamma}(\Sigma^- \rightarrow n\pi^-) = (1.09 \pm 0.06) \times 10^{-3}$. (GE)

Strong (Baryon-induced)

Refer also to abstract 14167.

13814 (ANL/HEP-7417) EXPERIMENTAL PROGRAM FOR SCATTERING-AMPLITUDE MEASUREMENTS. Yokosawa, A. (Argonne National Lab., Ill. (USA)). Feb 1974. 9p. (CONF-740226-1). Dep. NTIS $4.00.

From symposium on high energy physics with polarized beams; Argonne, Illinois, USA (8 Feb 1974).

The first-stage scattering amplitude measurements from 1 to 12 GeV/c involving a relatively simple experimental setup covering a small t region where one can accomplish a high precision measurement are discussed for the p–p system, which is the pure state of T = 1. (JFP)

13815 (ANL/HEP-7428) DIFFRACTIVE PROCESS IN SIX-PRONG PROTON–PROTON INTERACTIONS AT 205 GeV/c. Schultz, P. F.; Derrick, M.; Musgrave, B.; Schreiner, P.; Yuta, H. (Argonne National Lab., Ill. (USA)). 1974. 12p. (CONF-740713-3). Dep. NTIS $4.00.

From seventeenth international conference on high-energy physics; London, UK (1 Jul 1974).

The 6-prong events were studied in a 50,000 picture exposure of the 30-inch bubble chamber to a 205 GeV/c proton beam at the Fermi National Accelerator Laboratory. The data consists of complete measurements of 446 events containing a proton track with $P_{Lab} < 1.4$ GeV/c identified by ionization. A low mass diffractive peak is clearly seen in the events with 5 charged particles in the forward CM hemisphere. An analysis based on the rapidity distributions of the outgoing tracks and the missing mass gives a single diffractive cross section of 0.38 ± 0.05 mb, of which a quarter corresponds to the 4-constraint events $pp\pi^+\pi^+\pi^-\pi^-$. In the diffractive sample, only 0.1 ± 0.03 mb corresponds to events decaying through a Δ^{++} intermediate state. Comparing these data to the low mass enhancements seen in the 2- and 4-prong data in the experiment, one finds a systematic variation of the diffractive peak position with particle number. (auth)

13816 (JINR-E1-7901) MULTIPLICITY SYSTEMATICS OF π^0, K^0_s AND Λ PRODUCED IN HIGH ENERGY COLLISIONS. Berceanu, S.; Ponta, T. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation). 1974. 12p. Dep. NTIS (US Sales Only) $4.00.

It is shown that the experimental data on π^0, K^0_s and Λ multiplicities in π^-p and pp collisions can be parametrized by a unique function within the framework of the KNO semi-inclusive scaling prediction on larger energy ranges than those quoted earlier. However, the ratios of moments $\langle n^0 n_c\rangle\langle n\rangle^{-q}\langle n_c\rangle^{-1}$ seem to increase with energy. (auth)

13817 (NAL-CONF-74-26-THY) RISING TOTAL CROSS SECTION AND LARGE TRANSVERSE MOMENTUM PHENOMENA, TWO TOPICAL QUESTIONS AT VERY HIGH ENERGIES. Jacob, M. (National Accelerator Lab., Batavia, Ill. (USA)). Feb 1974. 24p. (CONF-740201-5). Dep. NTIS $4.25.

From topical conference on energy; Chicago, Illinois, USA (4 Feb 1974).

The review covers the proton–proton total cross sections and large transverse momentum phenomena. A few key properties already ascertained are pointed out. (JFP)

13818 (NP–20026) WHERE DO DIFFRACTIVE NUCLEONS GO? Kajantie, K.; Ruuskanen, P. V.; Sohlo, S. (Helsinki Univ. (Finland). Research Inst. for Theoretical Physics). Feb 1974. 24p. Dep. NTIS (US Sales Only) $4.25.

Nucleon and pion-nucleon distributions from the diffractive component in pp collisions are analyzed. Diffractive events are assumed to come from a mechanism $pp \to N^*p$, in which a proton is diffractively excited to a nova N^*. The decay properties of N^* are determined by assuming that a Pomeron-proton collision behaves as a proton-proton collision. Correlations within the diffractive component are computed and seen to be numerically small. Even interference with the pionization component does not reproduce the observed pattern of pion (in the plateau)–proton (in the fragmentation region) correlations. This may imply the existence of long-range correlations within the pionization component. (auth)

13819 (UCD-34-P-191-6) U. C. DAVIS HIGH ENERGY PARTICLE PHYSICS RESEARCH. Annual Progress Report, February 1973–March 1974. Klems, J.; Ko, W.; Lander, R. L.; Pellett, D. E.; Yager, P. M. (California Univ., Davis (USA). Dept. of Physics). Apr 1974. Contract AT(04-3)-34. 6p. Dep. NTIS $4.00.

During the period February 1973–March 1974, 100,000 photographs of the NAL 30-inch HBC were taken during its exposure to a mixed beam of π^+ mesons and protons at 100 GeV/c. Analysis of 50,000 photographs showed that for both π^+p and pp interactions the charged particle multiplicity distribution is of Poisson form for all but the lowest multiplicities. These occur more frequently than required to complete the Poisson distribution and may result from a second (diffraction dissociation) component. A small sample of 200 GeV π^+p and pp interactions was also obtained. This sample is under analysis. A proposal to study π^-d interactions at 200 and 400 GeV in the NAL 30-inch hybrid chamber was approved. A proposal to study hi P_T interactions was submitted to NAL. Also a proposal to study $K\bar{K}$ and $KK\bar{K}$ resonant structure was submitted to SLAC. Two other papers were published. One involved the observation of structure in the s-wave component of Kπ scattering. The other described a high resolution scintillator hodoscope using binary coding. (auth)

13820 ANGULAR DISTRIBUTIONS OF $\bar{p}D \to \pi^+\pi^-(n)$ AT INCIDENT MOMENTA BELOW 400 MeV/c. Krinsky, B.; Dickinson, M.; Sun, C.R. (Department of Physics, State University of New York at Albany, Albany, New York 12222). Phys. Rev. D 9: No. 5, 1256-1258 (1 Mar 1974).

We have measured the angular distributions of π^- for the reaction $\bar{p}d \to \pi^+\pi^-(n)$ at laboratory momenta below 400 MeV/c. The events were obtained from an exposure of 1.8×10^6 annihilations of antiprotons in the 30-in. BNL deuterium-filled bubble chamber. These angular distributions show strong forward peaking down to the region of very low center-of-mass momentum (~ 65 MeV/c). (auth)

13821 THE REACTION $pp \to pp\pi^+\pi^-$ AT 205 GeV/c. Derrick, M.; Musgrave, B.; Schreiner, P.; Yuta, H. (Argonne National Laboratory, Argonne, Illinois 60439). Phys. Rev. D 9: No. 5, 1215-1220 (1 Mar 1974).

The reaction $pp \to pp\pi^+\pi^-$ is studied at 205 GeV/c using the 30-in. bubble chamber at the National Accelerator Laboratory. The event selection is discussed in detail and the cross section is measured to be 0.68±0.14 mb. This cross section is higher than one would expect based on a simple power-law extrapolation of lower energy data. Peripheral production of a low-mass $p\pi^+\pi^-$ system dominates the reaction. The data are consistent with conservation of t-channel helicity. (auth)

13822 MEASUREMENT OF p-p INCLUSIVE CROSS SECTIONS AT VERY HIGH ENERGY. Ratner, L.G. (Accelerator Division, Argonne National Laboratory, Argonne, Illinois 60439); Ellis, R.J.; Vannini, G.; Babcock, B.A.; Krisch, A.D.; Roberts, J.B. Phys. Rev. D 9: No. 5, 1135-1161 (1 Mar 1974).

We measured the differential inelastic cross section $Ed^3\sigma/dP^3$ for particles produced in very-high-energy proton–proton collisions at the CERN Intersecting Storage Rings. We studied the inclusive reaction $p + p \to x +$ anything, where x was a π^+, K^+, or proton. The momenta of the two colliding beams varied from 15.3 to 26.5 GeV/c. This was equivalent to a single beam of 500 to 1500 GeV/c hitting a target. We measured the dependence of $Ed^3\sigma/dP^3$ on the transverse and longitudinal momenta of the outgoing particles, $P_\perp$ and $P_\parallel$. We detected these particles with a spectrometer containing magnets and scintillation and Čerenkov counters. The first two magnets steered particles with the correct $P_\perp$ and $P_\parallel$ down the axis of the spectrometer. The third magnet deflected the particles vertically for momentum analysis. A coincidence of the five scintillation counters indicated an event and the Čerenkov counters tagged it as a pion, kaon, or proton. The luminosity was measured by the Van der Meer method. We found that when $Ed^3\sigma/dP^3$ was plotted against $X = P_\parallel/P_{max}$, it was energy-independent from 12 to 1500 GeV, especially for π^+ data. This supports a type of scaling suggested by Feynman and Yang et al. At small X, the pion cross section has a flat maximum, while the proton cross section decreases slightly. When plotted against $P_\perp^2$, the pion and proton cross sections both behave as at lower energies; $\sim\exp(-4.0P_\perp^2)$. The pion cross section has a distinct forward peak $\exp(-10P_\perp^2)$ which is absent in the proton case. The K^+/π^+ ratio is about 10%, with rather poor statistics. (auth)

13823 ANALYSIS OF TWO-PRONG EVENTS IN PP INTERACTIONS AT 205 GeV/c: SEPARATION OF ELASTIC AND INELASTIC EVENTS. Barish, S.; Colley, D.; Derrick, M.; Musgrave, B.; Schreiner, P.; Yuta, H. (Argonne National Laboratory, Argonne, Illinois 60439). Phys. Rev. D 9: No. 5, 1171-1179 (1 Mar 1974).

We present results of complete measurements of the two-prong events observed in a 50000-picture exposure of the 30-in. hydrogen bubble chamber to a 205-GeV/c proton beam at the National Accelerator Laboratory. Using kinematic fitting, elastic and inelastic events are separated and cross sections are obtained. The total two-prong cross section is measured to be 9.77 ± 0.40 mb, of which 2.85 ± 0.26 mb represents the inelastic contribution. The total elastic cross section is measured to be 6.92±0.44 mb. Our data are consistent with the break in $d\sigma/dt$ at $|t| \sim 0.1$–0.2 $(GeV/c)^2$ observed at the CERN ISR. A prominent low-mass enhancement is observed in the distribution of missing-mass squared from the slow proton for the inelastic events. An analysis based on the missing-mass spectrum and the particle rapidities shows that this low-mass enhancement accounts for about 77% of the total inelastic two-prong cross section. The diffractive cross section in

the two-prong events is 2.20±0.25 mb, in agreement with certain two-component models. (auth)

13824 SYSTEMATIC STUDY OF $\pi^{\pm}$p, $K^{\pm}$p, pp, and $\bar{p}$p FORWARD ELASTIC SCATTERING FROM 3 TO 6 GeV/c. Ambats, I.; Ayres, D.S.; Diebold, R.; Greene, A.F.; Kramer, S.L.; Lesnik, A.; Rust, D.R.; Ward, C.E.W.; Wicklund, A.B.; Yovanovitch, D.D. (Argonne National Laboratory, Argonne, Illinois 60439). Phys. Rev. D 9: No. 5, 1179-1209 (1 Mar 1974).

Measurements of $\pi^{\pm}$p, $K^{\pm}$p, pp, and $\bar{p}$p elastic scattering are presented for incident momenta of 3, 3.65, 5, and 6 GeV/c and momentum transfers typically 0.03 to 1.8 GeV^2. The angle and momentum of the scattered particle were measured with the Argonne Effective Mass Spectrometer for 300000 events, yielding 930 cross-section values with an uncertainty in absolute normalization of ±4%. Only the K^+ and proton data show any significant change in the slope of the forward diffraction peak with incident momentum. The particle-antiparticle crossover positions are consistent with no energy dependence, average values being 0.14±0.03, 0.190±0.006, and 0.162±0.004 GeV^2 for π's, K's, and protons, respectively; these errors reflect both statistics and the ±1.5% uncertainty in particle-antiparticle relative normalization. Differences between particle and antiparticle cross sections isolate interference terms between amplitudes of opposite C parity in the t channel; these differences indicate that the imaginary part of the odd-C nonflip helicity amplitude has a $J_0(r(-t)^{1/2})$ structure for $-t < 0.8$ GeV^2, as predicted by strong absorption models. The cross section differences for $K^{\pm}$ and proton-antiproton are in qualitative agreement with the predictions of ω universality, the agreement improving with increasing energy. The corresponding quark-model predictions relating the $\pi^{\pm}$ and $K^{\pm}$ differences failed by more than a factor of 2. We have combined our $\pi^{\pm}$ cross sections with other data to better determine the πN amplitudes in a model-independent way; results of this analysis are presented. (auth)

13825 DIFFRACTION DISSOCIATION IN FOUR-PRONG PROTON-PROTON INTERACTIONS AT 205 GeV/c. Derrick, M.; Musgrave, B.; Schreiner, P.; Schultz, P.F.; Yuta, H. (Argonne National Laboratory, Argonne, Illinois 60439). Phys. Rev. D 9: No. 7, 1853-1856 (1 Apr 1974).

We analyze the diffraction process in four-prong pp interactions at 205 GeV/c. The $p\pi^+\pi^-$ state contributes only 25% to the proton dissociation and, as observed for momenta below 30 GeV/c, this state is confined to masses $\lesssim 3$ GeV. Substantial excitation occurs into states involving three or more pions and with masses as high as 7 GeV. Isovector-exchange background is small, as studied using the missing mass of the system recoiling from a prominent Δ^{++} state. (auth)

13826 PION PRODUCTION IN PP COLLISIONS AT 102 GeV/c. Bromberg, C.M.; Chaney, D.; Cohen, D.; Ferbel, T.; Slattery, P. (University of Rochester, Rochester, New York 14627); Chapman, J.W.; Cooper, J.W.; Green, N.; Seidl, A.A.; Vander Velde, J.C. Phys. Rev. D 9: No. 7, 1864-1871 (1 Apr 1974).

We present preliminary results on single-pion production and two-pion correlations making use of a 30 000-picture exposure of the ANL/NAL 30-in. hydrogen bubble chamber to 102 GeV/c protons. The data, when compared with that from lower energies, indicate approximate scaling of π^- production in the proton-fragmentation region, but show a continuing rise of the cross section at $y_{c.m.} = 0$. Stronger correlations are observed between pions of opposite charge than between pions of like charge. The variation with energy of the charge transferred between c.m. hemispheres is slow, as would be predicted by multiperipheral-type models. (auth)

13827 STUDY OF THE REACTION p + d⟶ He^3 + x^0. Brody, H.; Groves, E.; Van Berg, R.; Wales, W.D. (University of Pennsylvania, Philadelphia, Pennsylvania 19104); Maglich, B.; Norem, J.; Oostens, J.; Silverman, M.; Cvijanovich, G.B. Phys. Rev. D 9: No. 7, 1917-1932 (1 Apr 1974).

The missing-mass technique has been used to study the spectra of neutral mesons produced by 2- and 3-GeV protons in the reaction p + d → He^3 + x^0. Cross sections ($d\sigma/d\Omega_{c.m.}$) of about 10^{-34} cm^2/sr were observed for the π, η, and ω for 3-GeV protons. A peak with much smaller cross section was observed at a mass of 956 MeV. We have tentatively identified this peak as the η'. Cross sections for the π and η were nearly a factor of 10 larger at 2 GeV than at 3 GeV. Deviations from simple phase space were observed near two-pion threshold in both 2-GeV and 3-GeV data. Details of the experimental method and of the results are presented. (auth)

13828 SEARCH FOR MASSIVE LONG-LIVED PARTICLES IN ALUMINUM TARGETS IRRADIATED BY 300- AND 400-GeV PROTONS. Frankel, S.; Frati, W.; Resvanis, L.; Yang, W. (Department of Physics, University of Pennsylvania, Philadelphia, Pennsylvania 19174); Nezerick, F. Phys. Rev. D 9: No. 7, 1932-1939 (1 Apr 1974).

We have used a directional gas Čherenkov counter, which employed six phototubes to sample Čherenkov light from single particles having a $\gamma[\equiv (1-v^2/c^2)^{-1/2}]$ greater than ~10, to achieve accidental rates of less than one per day if operated near targets with surface radiation levels of as high as 10^{+3}R/h. The cosmic-ray background measured by our apparatus was reduced to less than one per day by mounting our directional Čherenkov counter above the irradiated targets and facing toward the earth. Two searches of a few days duration, after bombardments at energies of 300 and 400 GeV with 10^{16} protons at NAL, were made in 4-in.-thick targets of aluminum mounted just downstream from another aluminum target. No long-lived particles were observed with cross sections for production and capture of approximately less than a picobarn in a lifetime of a few to a few thousand hours. (auth)

13829 MEASUREMENTS OF DP BACKWARD ELASTIC SCATTERING AT 3.43, 4.50, 5.75, AND 6.60 GeV/c INCIDENT DEUTERON MOMENTUM. Dubal, L.; Hargrove, C.K.; Hincks, E.P.; McKee, R.J.; Mes, H. (National Research Council of Canada, Ottawa, Ontario, Canada K1A OR6); Thompson, A.C.; Bird, L.; Halliwell, C.H.; Morrison, R.W.; Walters, J.; McCaslin, J.B.; Smith, A.R. Phys. Rev. D 9: No. 3, 597-603 (1 Feb 1974).

Differential cross sections for dp elastic scattering from 60° to 175° center of momentum (c.m.) were measured at 3.43, 4.50, 5.75, and 6.60 GeV/c incident deuteron momentum. The measurements were made with a two-arm magnetic spectrometer, making use of multiwire proportional chamber detectors. The deuterons were accelerated at the Bevatron of the Lawrence Berkeley Laboratory. Data are compared with predictions of the baryon-pickup model and the one-pion-exchange model. The backward dip at 180° c.m. for 4.5 GeV/c, predicted by Craigie and Wilkin using the one-pion-exchange model, is not observed, but reasonable fits to the momentum variation and angular distributions are found. When the data are plotted against the variable Δ of the baryon-pickup model, the s dependence is greatly reduced. (auth)

13830 LARGE-ANGLE ELASTIC PROTON-PROTON POLARIZATION AT 5.15 GeV/c. Abshire, G.W.; Ankenbrandt, C.M.; Crittenden, R.R.; Heinz, R.M.; Hinotani, K.; Levy, S.I.; Neal, H.A.; Rust, D.R. (Department of Physics, Indiana University, Bloomington, Indiana 47401). Phys. Rev. D 9: No. 3, 555-559 (1 Feb 1974).

We present herein the initial results of a large-angle elastic p-p polarization experiment which is now in progress at the Argonne ZGS (Zero-Gradient Synchrotron) accelerator. Data for the incident proton momentum of 5.15 GeV/c are presented for $30° \lesssim \theta_{c.m.} \lesssim 90°$. These results, which extend to $t \approx -4.0$ (GeV/c)^2, represent the first high-statistics p-p polarization measurements for |t| values greater than ~2.5 (GeV/c)^2. We observe a minimum in the polarization near $t = -0.8$ (GeV/c)^2, a smooth increase in the polarization until a maximum is attained near $t = -1.8$ (GeV/C)^2, and then a monotonic decline in the polarization until the value of zero is reached at $\theta_{c.m.} = 90°$. The data are analyzed in terms of an optical model. (auth)

13831 PRODUCTION OF Σ^{*-} AND Ω^- BY Σ^- AND Ξ^- AT 24.6 GEV/C. Hungerbuehler, V. M. New Haven, CT; Yale Univ. (1973). 115p. University Microfilms Order No. 74-11,748.

Thesis (Ph. D.).

The reactions of 24.6 GeV/c Σ^- and Ξ^- incident on a scintillator target were studied with the Brookhaven-AGS negative hyperon beam, in a 1.4 million trigger counter-spark chamber experiment. The upper limits on production of Σ^{*-}-resonances times branching ratio into $\Lambda^0\pi^-$ and of Ξ^{*-}-resonances times branching ratio into Λ^0K^- are obtained. A single Ω^- that was produced in the scintillator target was observed, corresponding to a 115 μb production cross section by Ξ^-. The $\Lambda^0\pi^-$ mass spectrum was found to be consistent with a Deck-type threshold enhancement. (Diss. Abstr. Int., B)

13832 ONE PION PRODUCTION IN $\bar{p}$p INTERACTIONS AT 2.85 GeV/c. Hafen, E. S. Ames, IA; Iowa State Univ. (1973). 74p. University Microfilms Order No. 74-9117.

Thesis (Ph. D.).

One pion production in $\bar{p}$p interactions at 2.85 GeV/c was investigated using a total of 8526 events in three final states $p\bar{p}\pi^0$, $\bar{p}n\pi^+$, and $pn\pi^-$. These states were found to be contaminated by spurious fits to these states of events from other final states in such a way that the amount of Δ(1236) resonance production appeared to violate the isospin and charge conjugation invariance of the strong interaction. The $p\bar{p}\pi^-$ state was most severely affected by the contamination. A χ^2 cut applied to all three final states removed most of the apparent isospin and charge conjugation invariance violations. The production and decay of the Δ(1236) resonance was then studied, avoiding in so far as possible any assumption about the production mechanism. A coherent sum of decay amplitudes reproduced the mass structure of the Δ(1236) better than an incoherent sum. The $p\bar{p}\pi^0$ state was found to be nearly 100% $\Delta^+(1236)$ or $\bar{\Delta}^-(1236)$ production. The Δ^+ mass was measured as 1233 ± 4 (MeV/c^2) and the Δ^0 mass

as 1220 ± 7 (MeV/c^2). Both the amount of Δ(1236) production and the Δ^+ and Δ^0 masses depend on the parametrization of the mass dependence of the decay amplitudes of the Δ(1236). Spin density matrix elements were inconsistent with one pion exchange. (Diss. Abstr. Int., B)

13833 NUCLEON-NUCLEON SCATTERING NEAR 50 MeV. II. SENSITIVITY OF VARIOUS n-p OBSERVABLES TO THE PHASE PARAMETERS. Binstock, J.; Bryan, R. (Department of Physics and Cyclotron Institute, Texas A&M University, College Station, Texas 77843). Phys. Rev. D 9: No. 9, 2528-2538 (1 May 1974).

In the first paper in this series, we reported on a phase-shift analysis of existing p-p and n-p in the energy range of 47.5 to 60.9 MeV. Two results were emphasized. The first is that the available n-p data leave ϵ_1 undetermined within the range -10° to +3°, resulting in a range of phase-parameter solutions, rather than a single solution. The second result is that while ϵ_1 is very poorly determined, δ ($^1P_1$) is rather well determined, but at a value which appears to conflict not only with values obtained at adjacent energies, but also with the value (or narrow range of values) predicted by meson-theoretical models. In that paper it is reported that the Harwell n-p $d\sigma/d\Omega$ data are responsible for the value of δ ($^1P_1$). The remaining data, consisting only of σ_{tot} data, polarization data, and other $d\sigma/d\Omega$ data, are consistent with the theoretical predictions. In this paper we look more closely at the sensitivity of experimental observables to variations in the partial-wave parameters. We extend the number of experimental observables under study to twenty, and consider the effect on these of varying seven different phase parameters: δ ($^1Sd_0$)$_{np}$, δ ($^3S_1$), ϵ_1, δ ($^1P_1$), δ ($^3D_1$), δ ($^3D_2$), and δ ($^3D_3$). We discover that the best observable to fix δ ($^1P_1$) is still the differential cross section, and recommend, as in the first paper, that it be measured both at extreme forward and extreme backward angles. We also discover that the reason ϵ_1 is very poorly determined by the present data is that neither σ_{tot}, $d\sigma/d\Omega$, nor P is sensitive to changes in ϵ_1. We find that the experimental observables which are sensitive to ϵ_1 and can fix this parameter are, in order of decreasing sensitivity, A_{xz}, C_{pp}, A'_y, C_{KK}, A_y, Dt, C_{nn}, and A_{xx}. (auth)

13834 UPDATED CHARGED-PARTICLE MULTIPLICITY DISTRIBUTION FROM 205-GeV/c PROTON-PROTON INTERACTIONS. Barish, S.; Cho, Y.; Colley, D.C.; Derrick, M.; Engelmann, R.; Hyman, L.G.; Jaeger, K.; Musgrave, B.; Phelan, J.J.; Rest, J.; Schreiner, P.; Schultz, P.F.; Singer, R.; Yuta, H. (Argonne National Laboratory, Argonne, Illinois 60439); Voyvodic, L.; Walker, R.; Whitmore, J. Phys. Rev. D 9: No. 9, 2689-2691 (1 May 1974).

The charged-particle multiplicity distribution in 205-GeV/c proton-proton interactions is presented. In addition, the total diffractive contributions to each charged multiplicity are estimated assuming a factorizable Pomeron. (auth)

Strong (Meson-induced)

Refer also to abstract 13693.

13835 (BNL-18909) MEASUREMENT OF THE POLARIZATION PARAMETER AND DIFFERENTIAL CROSS SECTION IN K^+p ELASTIC SCATTERING FROM 1.7 TO 3.0 GeV/c. Barletta, W. A.; Ehrlich, R. D.; Etkin, A.; Hughes, V. W.; Mishina, M.; Patton, R.; Souder, P. A.; Zeller, M. E., Lazarus, D. M. (Yale Univ., New Haven, Conn. (USA); Brookhaven National Lab., Upton, N. Y. (USA)). [nd]. 13p. (CONF-740713-1). Dep. NTIS $4.00.

From seventeenth international conference on high-energy physics; London, UK (1 Jul 1974).

The asymmetry and differential cross section in the elastic scattering of positive kaons from a polarized proton target at 1.7, 2.1, 2.4, 2.7, and 3.0 GeV/c were measured. The experiment was carried out in a partially separated beam at the Brookhaven AGS with a dynamically polarized butanol target maintained at .5°K in a 25kG magnetic field. A system of plane and cylindrical multiwire proportional chambers located beam trajectories and detected both scattered and recoil particles. Preliminary event selection was achieved with scintillation counter hodoscopes. The experiment was designed to simultaneously measure scattering in the extreme backward and forward kinematic regions. The backward scattering data are significant as a test of the predictions of exchange degeneracy and as a check on a reported anomaly in the backward differential cross section. The high statistical accuracy obtained in the forward scattering data will strongly constrain future phase shift analyses and test Regge models at small -t. (auth)

13836 (COO-3065-74) STUDY OF THE COHERENT PRODUCTION REACTION $\pi^- + A \rightarrow \pi^- + \pi^0 + A$. Strawczynski, J. (Rochester Univ., N. Y. (USA). Dept. of Physics and Astronomy. 1974. 182p. (UR-475). Dep. NTIS $12.25.

Thesis.

The final state $\pi^- + \pi^0$ produced by 22.7 GeV/c π^- incident on a variety of complex nuclear targets: C, Al, Cu, Ag, Pb and U was measured. The experiment was performed at the Brookhaven A.G.S. using the spectrometer facility of the Lindenbaum-Ozaki Group. Sharp peaks were observed in the t' distribution of the events recorded using medium and heavy nuclei. This structure is localized to the range $|t'| < 0.02$ (GeV/c)^2 and consists of an almost pure ρ^- yield. The t' shape and Z dependence of these data indicate the presence of two production amplitudes: ρ^- production in the nuclear Coulomb field (Primakoff effect) and ρ^- production in the nuclear surface via ω^0 exchange. The data were analyzed using a model of coherent production including the Coulomb and hadronic interactions and their interference. The parameters of the model are the radiative width $\Gamma(\rho^- \rightarrow \pi^-\gamma)$, $C_{\pi\pi}$ a measure of the strength of the ω-exchange process, and ϕ the relative, phase of the two channels. These parameters are coupled and a range of acceptable solutions is provided. The optical model satisfactorily reproduces the qualitative features of the data. An upper and lower bound for the radiative width $\Gamma(\rho^- \rightarrow \pi^-\gamma)$ are obtained as $\Gamma_{min} < \Gamma(\rho^- \rightarrow \pi^-\gamma) < \Gamma_{max}$ $\Gamma_{min} = 30 \pm 10$ keV, $\Gamma_{max} = 80 \pm 10$ keV. A value of $\Gamma(\rho^- \rightarrow \pi^-\gamma)$ to 10 keV uncertainty may be obtained if the relative phase, ϕ, is specified. The simple quark model predicts $\Gamma = 120$ keV. The measurement of $C_{\pi\pi}$ is in moderate agreement with hydrogen data at lower energies. (auth)

13837 (JINR-P1-7924) SEPARATION OF THE DIFFRACTIVE COMPONENT IN π^--p INTERACTIONS AT pc = 40 GeV IN THE EFFECTIVE TARGET MASS ANALYSIS. Angelov, N.; Vishnevskaya, K. P.; Grishin, V. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1974. 16p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

The results on the diffractive dissociation of the pion in the reaction $\pi^- + p \rightarrow p +$ anything at 40 GeV/c where the proton was identified up to a momentum of 800 MeV/c are presented. The selection of events was made by using the effective target mass analysis. The topological cross sections were obtained in the range $MM^2 \leq 20$ GeV^2 and effective target mass $\tilde{M}_t \leq 150$ MeV. The total cross section of the pion diffractive dissociation is $\sigma_D = 2.32 \pm 0.12$ mb, and the average charged multiplicity is $\langle n_s \rangle = 3.47 \pm 0.17$. The distribution of the four-transfer momenta was fitted by the expression EXP (at) where the value of a $_{at}$ a = 10.9 ± 0.9 GeV^{-2} in the range $|t| < 0.3$ GeV^2. (auth)

13838 (RL-74-73) STUDY OF THE Q ENHANCEMENT IN THE REACTION $K^-p \rightarrow K^-\pi^-\pi^+p$ AT 14.3 GeV/c. Tovey, S. N.; Hansen, J. D.; Paler, K. (Science Research Council, Chilton (UK). Rutherford High Energy Lab.; Ecole Polytechnique, 75 - Paris (France); CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)). 1974. 22p. Dep. NTIS (US Sales Only) $4.25.

A study was made of the Q enhancement using 10,366 events in the reaction $K^-p \rightarrow K^-\pi^-\pi^+p$ at 14.3 GeV/c. A partial wave analysis is presented, based on the method developed at the University of Illinois. Results are presented on: the overall spin-parity structure of the Kππ system; the ratio of the $K^*\pi$ and Kρ decay amplitudes of the dominant $J^P = 1^+$ wave; and the coherence of the different partial wave amplitudes. Various interpretations of the Q enhancement are discussed. (auth)

13839 STUDY OF $K^+\pi^-$ SCATTERING IN THE REACTION $K^+p \rightarrow K^+\pi^-\Delta^{++}$ AT 12 GeV/c. Matison, M.J.; Barbaro-Galtieri, A.; Alston-Garnjost, M.; Flatté, S.M.; Friedman, J.H.; Lynch, G.R.; Rabin, M.S.; Solmitz, F.T. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). Phys. Rev. D 9: No. 7, 1872-1893 (1 Apr 1974).

We have studied $K^+\pi^-$ elastic scattering in the reaction $K^+p \rightarrow K^+\pi^-\Delta^{++}$ at 12 GeV/c and in the Kπ mass interval 800 to 1000 MeV. We have performed a partial-wave analysis in this Kπ mass region, dominated by the p-wave resonance K^* (890), in order to obtain information about the s-wave amplitude. We have extrapolated the $K^+\pi^-$ moments, total cross section, and p-wave cross section to the pion pole. The p-wave cross section is close to the unitarity limit and can be described by a Breit-Wigner function, with parameters $M = 896 \pm 2$ MeV and $\Gamma = 47 \pm 3$ MeV. We then perform an energy-independent phase-shift analysis of the extrapolated moments and total cross section using this Breit-Wigner resonance form, with parameters a previously determined small negative phase shift for the I=3/2 s wave. For the I=1/2 s-wave phase shift we find the so called "down" solution, which has a phase shift that rises slowly from 20° at M(Kπ) =800 MeV to 60° at M(Kπ) =1000 MeV. The energy dependence of this phase shift is well described by an effective range form, with a scattering length $a^1_0 = -0.33 \pm 0.05$ F. The so-called "up" solution is eliminated or has large χ^2 everywhere except for two overlapping mass intervals at M(Kπ) =890 and 900 MeV. However, due to limited statistics, we expect two solutions for the s wave very near the mass where the p wave is resonant. We then perform an energy-dependent

partial-wave analysis and find again no evidence for and s-wave resonance although, due to limited statistics, we could not exclude one at 890 MeV with $\Gamma < 7$ MeV. (auth)

13840 $K_L^0 p \rightarrow K_S^0 p$ SCATTERING FROM 1 TO 10 GeV/c. Brandenburg, G.W.; Johnson, W.B.; Leith, D.W.G.S.; Loos, J.S.; Luste, G.J.; Matthews, J.A.J.; Moriyasu, K.; Smart, W.M.; Winklemann, F.C.; Yamartino, R.J. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). Phys. Rev. D 9: No. 7, 1939-1956 (1 Apr 1974).

The differential cross sections for $K_L^0 p \rightarrow K_S^0 p$ scattering are presented in several momentum intervals between 1 and 10 GeV/c. The data are strongly peaked in the forward direction, characteristic of a large s-channel helicity-nonflip scattering amplitude in this reaction, and a distinct break in the differential cross section occurs at $|t| = 0.3$ GeV^2. The phase of the forward scattering amplitude, ϕ, is consistent with being independent of momentum. The average value of the phase, $\phi = -133.9 \pm 4.0°$, corresponds to a Regge trajectory $\alpha(0) = 0.49 \pm 0.05$ in agreement with the canonical ρ, ω^0 Regge intercept, $\alpha(0) \sim 0.5$. However, this result disagrees with the Regge trajectory determined from the energy dependence of the forward cross section, $\alpha(0) = 0.30 \pm 0.03$, indicating a breaking of the Regge phase-energy relation. Comparisons of $K_L^0 p \rightarrow K_S^0 p$ and $\pi^- p \rightarrow \pi^0 n$ scattering data reveal substantial differences in the energy dependence of the differential cross sections. Comparisons to KN charge-exchange data then suggest that direct-channel (absorption) effects may explain the differences in πN and KN channels. (auth)

13841 REACTION $K_L^0 p \rightarrow K_S^0 p$ AND THE POSSIBLE EXISTENCE OF A Z_0^* RESONANCE. London, G.W. (Brookhaven National Laboratory, Upton, New York 11973). Phys. Rev. D 9: No. 5, 1569-1571 (1 Mar 1974).

We show that the reaction $K_L^0 p \rightarrow K_S^0 p$ is very sensitive to the ambiguous I=0 KN phase-shift solutions because of the interference with the I=1 KN amplitudes. The cross sections and differential cross sections measured by different experiments in the 1800-MeV c.m. energy region favor one of the exotic I=0 p_1-resonance solutions and tend to reject the p_1-nonresonant solution. The χ^2/DF for nine cross-section points is 0.7 for the favored p_1-resonance solution and 3.1 for the p_1-nonresonant solution, while the respective χ^2/DF for the 25 independent normalized differential cross-section points are 1.2 and 2.4. (auth)

13842 PRODUCTION OF f^0 MESONS IN 4.5-GeV/c $\pi^- p$ INTERACTIONS. Holloway, L.E.; Huld, B.; Jordan, M.; Koetz, U.; Kruse, U.E.; Mortara, D.W. (University of Illinois at Urbana, Illinois 61801); Bernstein, S.; Margulies, S.; McLeod, D.W. Phys. Rev. D 9: No. 5, 1161-1170 (1 Mar 1974).

An optical spark chamber and neutron time-of-flight spectrometer experiment studied the reaction $\pi^- p \rightarrow \pi^+ \pi^- n$ at incident pion momentum of 4.5 GeV/c in the mass region of the f^0 meson. Analysis of the data shows no evidence for anomalous structure in the f^0 mass spectrum. The two-pion differential cross section in the f^0 region is consistent with Wolf's one-pion-exchange model for momentum transfers (squared) $-t \lesssim 0.7$ (GeV/c)^2. The differential cross section is larger than that predicted at high momentum transfer, and may be attributed to natural-parity-exchange contributions as evidenced in the f^0 decay distribution. (auth)

13843 INCLUSIVE PRODUCTION OF K^0_1, Λ^0, AND $\bar{\Lambda}^0$ IN 18.5-GeV/c $\pi^+ p$ INTERACTIONS. Stuntebeck, P.H.; Cason, N.M.; Bishop, J.M.; Biswas, N.N.; Kenney, V.P.; Shephard, W.D. (Department of Physics, University of Notre Dame, Notre Dame, Indiana 46556). Phys. Rev. D 9: No. 3, 608-620 (1 Feb 1974).

Data are presented for the single-particle inclusive reactions $\pi^+ p \rightarrow K^0_1 +$ anything, $\pi^+ p \rightarrow \Lambda^0 +$ anything, and $\pi^+ p \rightarrow \bar{\Lambda}^0 +$ anything at 18.5 GeV/c. We have studied the invariant cross section $Ed^3\sigma/dp^3$ in terms of the variables (P_L, P_T^2), (x, P_T^2), (y, P_T^2), and (y, P_T^2). The distributions for the longitudinal-momentum variable depend strongly on the type of particle produced. The K^0_1 distributions are not symmetric about $x = 0$, where x is the Feynman scaling variable; more K^0_1's are produced in the forward hemisphere, suggestive of beam fragmentation. The Λ^0 distributions peak in the backward hemisphere, suggestive of target fragmentation. The $\bar{\Lambda}^0$ distributions are significantly different from the Λ^0 distributions. Distributions of transverse momentum are fitted with the function $Ae^{(-BP_T^2)}$. The average transverse momentum of the K^0_1, Λ^0, and $\bar{\Lambda}^0$ increases logarithmically with the mass of the produced particle. Topological cross sections and multiplicity distributions are presented. We have studied the Λ^0 polarization as a function of $|t-t_{min}|$, x, and charge multiplicity. We find that the $\pi^- p$ data show a significant polarization for $0.5 \leq |t - t_{min}| \leq 1.5$ (GeV/c)^2 and for $-0.8 \leq x \leq -0.4$, while in the $\pi^+ p$ data the polarization is everywhere consistent with zero. (auth)

13844 NEGATIVE PION-PROTON ELASTIC SCATTERING NEAR ONE HUNDRED EIGHTY DEGREES BETWEEN SIX HUNDRED AND TWELVE HUNDRED EIGHTY MeV/c. Richards, T. J. St. Louis; St. Louis University (1972). 178p. University Microfilms Order No. 74-4563.

Thesis (Ph. D.).

The elastic differential cross sections for negative pion-proton scattering over the angular range 155 to 177° in the center of mass reference frame were measured at 33 incident pion momenta in the range 600 to 1280 MeV/c. The experimental method employed a liquid hydrogen target and a double arm spectrometer. The double arm spectrometer consisted of scintillation counters that detected both the scattered pions and the corresponding recoil protons and a bending magnet that momentum analyzed the protons. The experiment was performed at the Bevatron facility, Lawrence Berkeley Laboratory, Berkeley, California. The data from this experiment are compared to all other published data in this momentum region. The overall agreement between these data and the others is good. The data of this experiment are in good agreement with the results of the recent phase shift analysis by Almehed and Lovelace except between 700 and 800 MeV/c. The input to this phase shift analysis included the data of this experiment. In the momentum region between 700 and 800 MeV/c, the slope of the backward angular distribution goes rapidly through zero from negative to positive, and the magnitude of the differential cross section falls by more than a factor of ten. Momentum dependent structure is seen in the extrapolated differential cross sections at 180°. Two prominent dips in the 180° differential cross sections appear at 880 and 1150 MeV/c. This structure is discussed in terms of a direct channel resonance model that assumes only resonant partial waves are contributing to the cross sections for large scattering angles. (Diss. Abstr. Int., B)

13845 $\pi^+\pi^+$ AND $\pi^-\pi^+$ DIPION ELASTIC INTERACTIONS, INCLUDING COULOMB TERMS, STUDIED AT DIPION ENERGIES BELOW 700 MeV. Prukop, J. P. Jr. Notre Dame, IN; Univ. of Notre Dame (1974). 216p. University Microfilms Order No. 74-8897.

Thesis (Ph. D.).

Data are presented on the reactions $\pi^+ p \rightarrow \pi^+\pi^+ n$ and $\pi^- p \rightarrow \pi^-\pi^+ n$ at 5 GeV/c. The data is concentrated in the low dipion mass region so that an improved extraction of the $\pi\pi$ phase shifts and scattering lengths is possible in the dipion mass region below 700 MeV. The experimental apparatus, consisting of a large magnet spectrometer with magneto-strictive spark chambers, is detailed and has continuously good acceptance in all physical variables for dipion mass below 700 MeV and momentum transfer below 0.16 GeV^2. The effects of the Coulomb amplitude are included and off-shell in its gauge invariant form it is found to have very little effect. The pure I = 2 state $\pi^+\pi^+$ yields larger phase shifts for both δ_0^2 and δ_1^2 than previously reported. The corresponding scattering length $a_2 = -0.36$ F is also big and near or exceeds the limit allowed by some models. The $\pi^-\pi^+$ analysis yields a large $a_0 = 0.60$ F and phase shifts consistent with the "up" solution to the δ_0^0 below the ρ mass. (Diss. Abstr. Int., B)

13846 COHERENT PION PRODUCTION FROM DEUTERIUM BY 7 GeV/c POSITIVE PIONS. Harrison, D. M. Toronto; Univ. of Toronto (1972). National Library of Canada, Ottawa.

Thesis (Ph.D.).

Coherent production of 3π and 4π of deuterium was measured in a 650,000 picture exposure of the 30 in. MURA-ANL deuterium filled bubble chamber to 6.95 GeV/c π^+. The total cross section for the reaction $\pi^+ d \rightarrow \pi^+\pi^+\pi^- d$ was measured to be 430 ± 40 μb, and this final state was found to be dominated by ρ^0 production. In addition, A_1^+ and d^{*++} production is observed, evidence for A_2^+ production is presented, and the existence of $\rho^0\omega$ interference in this final state is demonstrated. The cross section for the reaction $\pi^+ d \rightarrow \pi^+\pi^+\pi^0\pi^- d$ was measured to be 65 ± 8 μb, and ω, d^{*++} and some ρ production is observed. (Diss. Abstr. Int., B)

13847 $\pi^+ p$ BACKWARD ELASTIC SCATTERING BETWEEN 1.25 AND 3.0 GeV/c. Va'vra, J. Montreal; McGill Univ. (1973). National Library of Canada, Ottawa.

Thesis (Ph.D.).

The backward differential cross section for the $\pi^+ p$ elastic scattering was measured at the Berkeley Bevatron. The measurements cover a center-of-mass angular region of 125 to 178°. In the case of $\pi^- p$ interaction there are 31 momenta between 1.28 and 3.0 GeV/c and for the $\pi^+ p$ data there are 16 momenta between 1.25 and 2.0 GeV/c. The experiment contributed over 900 data points. The statistical accuracy of the data is, in general, $\pm(4-10)\%$. Considerable structure in the angular distributions is found, in agreement with previous experiments in this momentum region. A double arm spectrometer, consisting of counter hodoscope arrays and a bending magnet, was used to detect elastic events, which were identified by angle-angle correlations and precise time-of-flight measurements on the final state particles.

The data are discussed in terms of the phase shift analysis, the direct channel resonance and Regge models. It was found that the existing phase shift solutions do not reproduce the data. The comparison with the direct channel resonance models is reasonably good. The data do not support the Regge models at these energies. (auth) (Diss. Abstr. Int., B)

13848 SYSTEMATIC STUDY OF K* CHARGE EXCHANGE FROM 3 TO 6 GeV/c. Diebold, R.; Ayres, D.S.; Greene, A.F.; Kramer, S.L.; Pawlicki, A.J.; Wicklund, A.B. (Argonne National Laboratory, Argonne, Illinois 60439). Phys. Rev. Lett. 32: No. 16, 904-907 (22 Apr 1974).

Differential cross sections for $K^-p \to \bar{K}^0n$ and $K^+n \to K^0p$ have been measured at 3, 4, and 6 GeV/c using a data sample of 6000 events. Contrary to simple exchange-degenerate models, the ratio of K^+ to K^- cross sections was found to be approximately 1.35, with little dependence on either s or t. Both reactions show a shallow dip near the forward direction, suggesting the importance of spin-flip amplitudes. (auth)

13849 NEW PARAMETERS FOR Δ^{++} RESONANCES FROM 2170 TO 3490 MeV IN π^+p BACKWARD ELASTIC SCATTERING. Rey, C.A.; Lennox, A.J.; Poirier, J. (Physics Department, University of Notre Dame, Notre Dame, Indiana 46556); Pretzl, K.P. Phys. Rev. Lett. 32: No. 16, 908-911 (22 Apr 1974).

Data obtained in a π^+p backward-elastic-scattering experiment from 2 to 6 GeV/c were used to investigate s-channel Δ^{++} resonances between 2170 and 3490 MeV/c^2. Two different models for fitting the energy dependence of $(d\sigma/d\Omega)_{180°}$ gave good fits. We present values for the masses, widths, parities, and the product of the spin and elasticity for the Δ (2420), Δ (2850), and Δ (3230) as well as the recently observed negative-parity resonance at ~2200 MeV/c^2. (auth)

13850 PRODUCTION MECHANISMS IN 12.6 GeV/c K^- PROTON INTERACTIONS. Slaughter, A. J. New Haven, CT; Yale Univ. (1973). 315p. University Microfilms Order No. 74-11,885.

Thesis (Ph. D.).

Results are presented for a study of the reaction mechanisms as a function of multiplicity in 12.6 GeV/c K^-p interactions. The following final states are investigated: $K^-p \to K^-p$, $\bar{K}^0\pi^-p$, $K^-\pi^0p$, $K^-\pi^+n$, $\bar{K}^0\pi^-\pi^0p$, $K^-\pi^+\pi^-p$, $\bar{K}^0\pi^-\pi^+p$, $K^-\pi^+\pi^-\pi^0p$, $\bar{K}^0\pi^-\pi^+\pi^0p$. It is found that 70 to 80% of the three body final states are quasi two body, $K^-p \to K^*(890)p$, $K^-p \to K^*(1420)p$, and $K^-p \to K^-(\pi N)$, a target dissociation process. The four body states are dominated by beam and target dissociation, $K^-p \to Q^-p$, $K^-p \to L^-p$, and $K^-p \to K^-(\pi^+\pi^-p)$. The nondiffractive components include $K^{*0}\Delta^0$ and single resonance production such as $K^-p \to K^-\pi^-\Delta^{++}$ with no threshold enhancement in the $\Delta^{++}\pi^-$ mass. The five body states, $\bar{K}^0\pi^-\pi^-\pi^+p$ and $K^-\pi^+\pi^-\pi^0p$, are very similar; both contain a beam dissociation type of reaction, $K^-p \to K^{*-}\rho^0$ at the 10 to 20% level, and a nondiffractive $K^*(890)\pi^-\Delta^{++}$ component at the 10% level. The $K^-\pi^+\pi^-\pi^0p$ state also contains complimentary $K(\omega p)$ and $(K\omega)p$ diffractive processes. Both five body states contain copious amounts of single resonance production. (Diss. Abstr. Int., B)

13851 RELATIONS BETWEEN THE BALL AMPLITUDES AND THE ZEROS OF ρ^0-DECAY MATRIX ELEMENTS. Vasavada, K.V. (Department of Physics, Indiana-Purdue University, Indianapolis, Indiana 46205); Gutay, L.J. Phys. Rev. D 9: No. 9, 2563-2566 (1 May 1974).

We present experimental evidence that in $\pi^-p \to \rho^0n$, $'\rho_{1-1}{}^{11} \simeq 0$ in an extended range of s and t and Re $'\rho_{10}{}^{11} = 0$ at $t \simeq -\mu^2$ independently of s. These two facts are shown to be correlated and imply fundamental relations between the Ball invariant amplitudes. (auth)

Particle Interactions and Properties (Theoretical)

General

Refer also to abstracts 14417, 14436, 14465, and 14478.

13852 (ANL/HEP-7423) REVIEW OF THE "FEYNMAN GAS" AND INCLUSIVE SPECTRA. Thomas, G. H. (Argonne National Lab., Ill. (USA)). Jun 1974. 45p. (CONF-740629-2). Dep. NTIS $5.25.

From fifth international symposium on many particle hadrodynamics; Leipzig, F. R. Germany (4 Jun 1974).

This talk is a review of the fluid analogy of Bjorken, Feynman and Wilson. Mainly covered is recent work on the formulation of the analogy as well as some phenomenological applications. It is realized that the language of statistical mechanics is confusing and perhaps misleading to a large number of people. Therefore a special effort is made to present the assumptions, formalism, models, and phenomenology in the more standard Regge language. At the end, the explicit connection is made between the results and formalism so obtained, to equilibrium statistical mechanics. (auth)

13853 (LBL-2640) EXPLOITATION OF THE SMALL PION MASS IN MULTI-REGGE THEORY. Shankar, R. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 26 Apr 1974. Contract W-7405-eng-48. 112p. Dep. NTIS $8.75.

Thesis.

A collection of four papers is discussed which address themselves to problems in multi-Regge theory and lean heavily on the hypothesis of pion pole dominance in arriving at the solutions. The meaning of multi-Regge diagrams (whose superficial resemblance to Feynman diagrams seemed to be the source of some prevalent misconceptions) and the rules for manipulating the same are discussed. An affirmative and quantitative answer is provided to the question of whether or not the pomeron can and does occur more than once in the amplitude for a single process. The significant feature of the analysis, based on the pion pole dominance hypothesis, is that only the context in which the pomeron occurs (high energy diffractive amplitudes) is assumed and the result is independent of the specific J-plane singularity associated with the pomeron. Triple-Regge processes are dealt with. In the former, the omission of off-diagonal coefficients (G_{ijk}; $i \neq j$) in triple-Regge fits to the data is criticized, and the exchange degeneracy arguments adduced in support of the above omission are shown to be without basis in the triple-Regge region. Calculations within the pion pole dominance model are presented to show that one of the omitted off-diagonal coefficients could possibly be responsible for a substantial fraction (typically 30%) of the inclusive cross section. The salient features of the measured diagonal coefficients (G_{iii}) are correlated with the role of the pion mass in the triple-Regge region. In particular, the observed delay in the convergence of the triple-Regge expansion in the variable (S/M^2) describing the exclusive reggeons, resulting from the largeness of the coefficients G_{RRP} and G_{RRP} compared to G_{PPP} and G_{PPR}, is tied in with the circumstance that while the latter pair is independent of the pion mass the former is controlled by it in an essential way. (auth)

13854 HADRON DISTRIBUTIONS IN THE REACTIONS HADRON + HADRON → LEPTON PAIR + HADRONS AND TWO VIRTUAL PHOTONS → HADRONS, AND TESTS OF THE PARTON MODEL. Chen, M. (Stanford Linear Accelerator Center, Stanford, California 94305). Phys. Rev. D 9: No. 5, 1453-1458 (1 Mar 1974).

The parton-model description of the final-state hadron distributions can be characterized in terms of a few fragmentation regions and plateaus. We discuss such distributions in the reactions hadron + hadron → lepton pair + hadrons and virtual photon + virtual photon → hadrons; we also compare different distributions as tests of the parton model, and discuss kinematical conditions for the validity of the asymptotic descriptions of the distributions and the tests. From this discussion, we conclude that most of these asymptotic descriptions may be valid only at extremely high energies and a good nonasymptotic model is probably needed to describe these final-state hadron distributions at presently available energies. (auth)

13855 SPIN AND LOCALIZATION FOR ELEMENTARY SYSTEMS. Kálnay, A.J. (Centro de Física, Instituto Venezolano de Investigaciones Cientificas(IVIC), Apartado 1827, Caracas, Venezuela); Torres, P.L. Phys. Rev. D 9: No. 6, 1670-1674 (15 Mar 1974).

One of us (A.J.K.) has found the position operator for the Lorentz-invariant localization of scalar mesons, electrons, neutrinos, and photons. It was found uniquely except for an unknown constant for the electrons. With a set of postulates we find uniquely the spin angular-momentum tensor for the electrons and the value of that constant. We also find some general common properties for all the particles considered. (auth)

13856 INTEGRAL EQUATION APPROACH FOR THE MULTIPLICITY GENERATING FUNCTION. Mak, Se-Yuen. Providence; Brown University (1973). 46p. University Microfilms Order No. 74-3048.

Thesis (Ph. D.).

A multiperipheral-like integral equation for the generating function of the multiplicity distribution is derived and solved. The starting point is the Mueller-Regge model, and the integral equation therefore involves only inclusive parameters. A one-to-one correspondence between this result and that of an exclusive multiperipheral model is also established. Explicit expressions for the multiplicity distribution and correlations are obtained. Possible applications and generalizations, such as cases with "approach to scaling in the central region" and "exchange degeneracy", are discussed. (Diss. Abstr. Int., B)

13857 HIGH ENERGY PHYSICS INDEX. Volume 10, 1972. Subject Index. Leopoldshafen, Ger.; Zentralstelle fuer Atomkernenergie-Dokumentation (1974). 741p.

13858 HIGH ENERGY PHYSICS INDEX. Volume 11, No. 26, 1973. Leopoldshafen, Ger.; Zentralstelle fuer Atomkernenergie-Dokumentation (1973). 99p.

13859 HIGH ENERGY PHYSICS INDEX. Volume 12, No. 8, 1974. Leopoldshafen, Ger.; Zentralstelle fuer Atomkernenergie-Dokumentation (1974). 97p.

13860 HIGH ENERGY PHYSICS INDEX. Volume 12, No. 10, 1974. Leopoldshafen, Ger.; Zentralstelle fuer Atomkernenergie-Dokumentation (1973). 75p.

13861 HIGH ENERGY PHYSICS INDEX. Volume 12, No. 11, 1974. Leopoldshafen, Ger.; Zentralstelle fuer Atomkernenergie-Dokumentation (1973). 81p.

13862 ACTION PRINCIPLE FOR A RELATIVISTIC STRING IN AN EXTERNAL SCALAR FIELD. Hashimoto, N.; Yoneya, T. (Hokkaido Univ., Sapporo). Lett. Nuovo Cim.; 10: No. 7, 265-269 (15 Jun 1974).

String interactions with an external scalar field are discussed. It is shown that the quantum mechanics of a string with the given Lagrangian reproduces the conventional dual-resonance model of unit intercept. A manifestly covariant quantization is performed. (JFP)

13863 NULL-PLANE COMMUTATORS AND SUM RULES. Ahmed, M. A. (Univ. of Khartoum, Sudan). Lett. Nuovo Cim.; 10: No. 6, 262-264(8 Jun 1974).

Null-plane models of current commutators were used previously to derive fixed-mass sum rules. A regularized definition of the null-plane commutator is given in the case in which the limit $x^+ \to 0$ is of singular nature. This then leads to a form of the sum rule in which multiplicative regularization by a known function occurs. (JFP)

13864 O FIZIKE I ASTROFIZIKE. Kakie Problemy Predstavlyayutsya Seichas Osobenno Vazhnymi i Interesnymi. (Physics and Astrophysics. What are the Especially Interesting and Important Problems). Ginzburg, V. L. Moscow; Izdatel'stvo Nauka Glavnaya Redaktsiya Fiziko-Matematicheskoi Literatury (1974). 120p.

The most important problems in physics and astrophysics today are discussed, even though the point of view and observations must necessarily be controversial and subjective. In the field of macrophysics the following problems are presented: controlled thermonuclear synthesis, high-temperature super-conductivity, new substances (the problem of creating metallic hydrogen and a number of other materials), metallic exiton (electron-hole) liquid in semi-conductors, superconducting phase transitions, behavior of a substance in very strong magnetic field, very powerful lasers, liquid crystals, and superheavy elements. In the field of microphysics the following problems are discussed: strange particles, fundamental length (quantum space), interaction of particles at very high energies, weak interactions (violation of CP-invariance), nonlinear phenomena in very strong electromagnetic fields and the microphysics of yesterday, today and tomorrow. Problems in the field of astrophysics comprised the following: experimental confirmation of the general relativity theory, gravitational waves, the cosmological problem, quasars, neutron stars, origin of cosmic rays, neutrino astronomy, and the present state of development of astronomy. (SJR)

13865 ARE THERE ANOMALOUS LEPTON–HADRON INTERACTIONS? Pati, J.C. (Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742); Salam, A. Phys. Rev. Lett. 32: No. 19, 1083-1086 (13 May 1974).

It is remarked that the recently observed near constancy of σ (e^+e^- → hadrons) over a large range of center-of-mass energy may reflect the presence of a new class of short-range lepton–hadron interactions. This can be tested by a comparison of e^-p versus e^+p scatterings and a study of the spin, parity, and charge conjugation of the final product in annihilation as well as apparent deviations from scaling in $e^\pm p$ and $\mu^\pm p$ scatterings. (auth)

13866 SOME USEFUL PROPERTIES OF A THEORY OF VARIABLE MASS PARTICLES. Greenberger, D. M. (City Coll., New York). J. Math. Phys. (N. Y.); 15: No. 4, 395-405 (Apr 1974).

By a simple extension of the canonical formalism, one can include mass and proper time as dynamical variables in mechanics. Such a theory allows one to treat particles with variable mass and also classically decaying particles. The theory has other properties which offer a fresh approach to classical dynamics. For example, the inertia of a system becomes an active concept, and the rest mass of an interacting particle changes to include its binding energy. Also, the proper time as measured by a clock on a decaying particle runs at a different rate from a clock on a stable particle. This effect causes a "decay red shift" to be present in classically decaying systems, over and above other red shift effects. The effect could be used to remove the acausal properties of "pre-acceleration" in radiative reaction, and it is suggested that for rapidly decaying massive objects, like quasars, this effect might be responsible for part of their red shift. (auth)

13867 POTENTIAL THEORY ANALOGY TO THE DUAL ABSORPTION MODEL. Horvath, J. J. Riverside, CA; University of California (1973). 69p. University Microfilms Order No. 74-9248.

Thesis (Ph. D.).

The concept of geometry in the dual absorption model of Harari is used as an incentive to study potential problems. Specifically, the harmonic oscillator plus hard core potential is examined nonrelativistically, where the radius of the core therefore gives the potential a geometry. Employing the zero-width approximation, the bound states of the system are studied using nonrelativistic Regge theory, and an attempt is made to write the imaginary part of the impact parameter amplitude, IMA(b,E), which is a significant quantity in high energy scattering theory. It is found that expressions are in exact qualitative agreement with the predictions of the dual absorption model for inelastic scattering, namely that IMA(b,E) is dominated by the intermediate, or peripheral, impact parameters. A similar analogy between the diffractive, or quasi-elastic, component of the dual absorption model and both the harmonic oscillator and Veneziano models is also found in that the small impact parameters are found to be the most important. (Diss. Abstr. Int., B)

13868 NEW GEOMETRICAL REPRESENTATION OF THE PHYSICAL WORLD. Liu, T. C. Knoxville, TN; Univ. of Tennessee (1973). 187p. University Microfilms Order No. 74-11,268.

Thesis (Ph. D.).

A new theory of the physical world is presented in which there are only two fundamental quantities, length and inverse mass. These are combined to form a four-dimensional manifold consisting of three space dimensions and one of inverse mass. All other quantities are defined in terms of these basic dimensions. When this four-dimensional space is suitably quantized, the masses of the stable elementary particles, the magic numbers of nuclei, and the closed shells of atoms are found to have simple geometrical significance and are accurately predicted. The quantum numbers, decay schemes and mean half-lives of the elementary particles are also found to have simple interpretations and the correct values. The four basic physical constants—e, G, c, and h—turn out to be natural invariants resulting from the space quantization and are precisely predicted, as are the mechanisms and coupling constants of the strong, electromagnetic, weak and gravitational interactions. The results of both relativity and quantum mechanics are derived from this theory, including the Lorentz contraction, time dilation, relativistic mass, photon energy equation, energy-momentum equation, Heisenberg uncertainty principle, DeBroglie waves, Klein-Gordon equation and Pauli exclusion principle. The known conservation laws all turn out to correspond to certain geometrical invariants. Because of the assumed geometry, the number π is found to have special, basic significance. (Diss. Abstr. Int., B)

13869 QUANTUM NUMBERS AND QUARK–PARTON FRAGMENTATION MODELS. Cahn, R.N.; E. William Colglazier (Stanford Linear Accelerator Center, Stanford, California 94305). Phys. Rev. D 9: No. 9, 2658-2669 (1 May 1974).

Cascade models for quark hadron fragmentation are displayed. These models illustrate many of the predictions of the parton model for inclusive reactions. Multiplicities are constructed to go as $C_h \ln(s/m^2)$ in hadron–hadron collisions and as $C_{++} \ln(Q^2/m^2)$ in e^+e^- annihilation, implying a multiplicity in leptoproduction of $C_{++} \ln(Q^2/m^2) + C_h \ln(\omega - 1)$. However, Feynman's conjecture that quark quantum numbers are retained, on the average, in the parton fragmentation region is not necessarily true. This was first noted by Farrar and Rosner in a model with meson emission included if multiplicities grow no faster than logarithmically. In cascade models a weaker version of Feynman's conjecture is found to be true in general and this version is accessible experimentally. Also, triality is found to play a significant role, suggesting that C_{++} need not equal C_h. Other implications of cascade models are also explored for hadron–hadron collisions, e^+e^- annihilation, and leptoproduction, for both small and large transverse momentum of the produced particles. (auth)

Electromagnetic

Refer also to abstracts 13804, 13938, 14041, 14427, and 14438.

13870 (DESY-73-66, pp 3-65) PHOTOPRODUCTION WITH ALMOST REAL PHOTONS. Kramer, G. (DESY, Hamburg). Dec 1973.

From proceedings of the seminar on e–p and e–e storage rings; Hamburg, Germany (8 Oct 1973).

Photoproduction data are obtained from electroproduction in the limit of small momentum transfer squared of the electron. The photoproduction of new particles especially the W boson is emphasized, although hadron photoproduction is mainly emphasized. The discussed phenomena include the rise of the total pp cross section, the diffraction minima in pp elastic scattering, the diffractive peak in inclusive pp scattering, and new phenomena in inclusive production in the central region. (JFP)

13871 (DESY-73-66, pp 67-93) POSSIBLE WAY TO LOOK AT DEEP INELASTIC PHENOMENA. Preparata, G. (Brookhaven National Lab., Upton, NY). Dec 1973.

From proceedings of the seminar on e–p and e–e storage rings; Hamburg, Germany (8 Oct 1973).

An attempt is made to set up a realistic framework by means of a massive quark model to study deep inelastic phenomena in particular multiplicity correlations, spin effects, scaling laws, etc. The inclusive processes e^+e^- and eN(γN) and the exclusive processes e^+e^- form factors, and eN→ definite final states are considered. (JFP)

13872 (DESY-73-66, pp 95-120) INELASTIC LEPTON SCATTERING. Smith, C. H. L. (CERN, Geneva). Dec 1973.

From proceedings of the seminar on e–p and e–e storage rings; Hamburg, Germany (8 Oct 1973).

The discussion of inelastic lepton scattering covers eN→ e + anything, eN→ eH + anything, neutral currents in eN→ e + anything, μN→μ + anything, and e^+e^- interactions, and eN→ ν + anything interactions. (JFP)

13873 (DESY-73-66, pp 289-310) SOME EXPERIMENTS AND DETECTOR CONFIGURATIONS FOR ep SCATTERING. Berger, C.; Jordan, C.; Luebelsmeyer, K.; Mistry, N. Dec 1973.

From proceedings of the seminar on e–p and e–e storage rings; Hamburg, Germany (8 Oct 1973).

The kinematics of ep scattering in the usual one-photon exchange approximation is shown. Also experiments where only the scattered electron is detected are described, and a detector for final state hadrons is described. (JFP)

13874 (RL-74-65) DEEP INELASTIC STRUCTURE FUNCTIONS OF THE PHOTON. Worden, R. P. (Science Research Council, Chilton (UK). Rutherford High Energy Lab.). Apr 1974. 20p. Dep. NTIS (US Sales Only) $4.00.

Three independent structure functions of a real photon can be measured in photon–photon collisions in e^+-e^- storage rings. These are M_1 and M_L (related to the usual structure functions W_1 and νW_2, as defined for any target) and a third function M_3, which arises from the strong plane polarization of the colliding photons. Using a dispersion relation in the photon mass it is shown that M_3 and the longitudinal structure function M_L both scale and are independent of the vector-dominant hadronic structure of the real photon. Therefore in a parton model, or in the quark light-cone algebra, they are given by the bare quark box diagrams which also dominate when both photons have large q^2; this uniquely predicts the behavior $M_L = [1/2\pi \Sigma e_j^2]\, 4x(1-x)$ $M_3 = [1/2\pi \Sigma e_j^2]\, (-x^2)$ for the real photon structure functions in the Bjorken limit ($q_j^2 \to -\infty$, $q_j^2 = 0$, $x = -q_j^2/2q_1 \cdot q_2$ = constant). (auth)

13875 MULTIPLE BACKWARD SCATTERING OF ELECTRONS. Boyarshiniv, L. M. Yadern. Fiz.; 19: No. 5, 1059-1061 (May 1974). (In Russian).

The multiple (up to 7 times) backward scattering of the electron beams emitted by hard β-sources is studied for the first time. The experimental results are used to predict the characteristics of multiple (up to 16 times) scattering of electrons. (auth)

13876 HARD-PHOTON THEOREMS FOR RADIATIVE PION-PROTON SCATTERING. Haddock, R.P.; Leung, K.C. (University of California at Los Angeles, Department of Physics, Los Angeles, California 90024). Phys. Rev. D 9: No. 7, 2151-2163 (1 Apr 1974).

Low's prescription for imposing gauge invariance is used to construct a reasonably general form of the amplitude for $\pi^0 p \to \pi^0 p\gamma$, excluding magnetic moment radiation from the internal strongly interacting structure. The explicit k dependence of the amplitude is exhibited and the breakdown of Low's result (that the first two terms in the expansion in k are model-independent) is examined in the hard-photon regime. We then consider possible hard-photon theorems and a program to determine unknown form factors in the off-shell scattering amplitude, in the proton magnetic moment, and in the radiation of the resonant π p system, e.g., magnetic moment radiation from the Δ (1236). (auth)

13877 LARGE-ANGLE PROTON AND PION PRODUCTION IN DEEP-INELASTIC ELECTRON SCATTERING. Ahrens, L.; Berkelman, K.; Brown, G.S.; Cassel, D.G.; Francis, W.R.; Garbincius, P.H.; Harding, D.; Hartill, D.L.; Hartmann, J.L.; Loveless, R.L.; Rohlfs, R.C.; White, D.H. (Laboratory of Nuclear Studies, Cornell University, Ithaca, New York 14850); Sadoff, A.J. Phys. Rev. D 9: No. 7, 1894-1917 (1 Apr 1974).

We have measured ep, $e\pi^+$, and $e\pi^-$ coincidences for scattered electrons in the range Q^2=0.4 to 2.2 GeV^2 and W=2 to 4 GeV. We find (a) that vector-meson production decreases with Q^2 more rapidly than does the total virtual-photon–proton cross section, more rapidly even than the prediction of simple vector dominance, (b) that the slope of the t distribution in ρ and ω production becomes flatter with increasing Q^2 and seems to be at least approximately a function of the single variable $x_\rho = (Q^2 + m_\rho^2)/2M\nu$, (c) that the fraction of final states containing a proton decreases with increasing Q^2, (d) that in the central region of longitudinal momenta the inclusive π^+ yield seems to increase relative to the π^- yield as Q^2 increases, and (e) that the average transverse momentum of π^- is greater than of π^+ in the central region of longitudinal momenta. (auth)

13878 SUM RULE FOR DEEP-INELASTIC ELECTROPRODUCTION FROM POLARIZED PROTONS. Ellis, J. (Lauritsen Laboratory of Physics, California Institute of Technology, Pasadena, California 91109); Jaffe, R. Phys. Rev. D 9: No. 5, 1444-1446 (1 Mar 1974).

A sum rule is derived for the asymmetry in deep-inelastic scattering of polarized electrons from polarized protons: $\int_0^1 d\xi\ g^{en}(\xi) \simeq 0.15 g_A$. The result follows from the quark light-cone algebra and the assumption that strange quarks do not contribute to the asymmetry. The latter is justified by conventional parton-model arguments. (auth)

13879 SPECULATIONS ON THE BREAKDOWN OF SCALING AT 10^{15} CM. Chanowitz, M.S.; Drell, S.D. (Stanford Accelerator Center, Stanford University, Stanford, California 94305). Phys. Rev. D 9: No. 7, 2078-2091 (1 Apr 1974).

We discuss the hypothesis that scaling in deep-inelastic electron–nucleon scattering is a "preasymptotic" phenomenon, which will be broken at energies large enough to probe the structure of the constituents of the nucleon. In particular, we consider a model in which the constituents are light (i.e., $M \lesssim M_p$) and are bound by a very heavy gluon ($M_G > M_p$), which induces a small "size" in the constituents of order M_G^{-1}. The experimental implications of this hypothesis are discussed, primarily for the region of momentum transfers $M^2 \ll Q^2 \ll M_G^2$. In a bound-state model, using the Bethe–Salpeter equation in ladder approximation, we show that the deviations from simple scaling behavior in spacelike scattering and timelike annihilation processes are correlated and measure the "size" of the constituent. Finally, we show that the hypothesis that the constituent has structure is not inconsistent with local current algebra and, in particular the Adler sum rule for neutrino–nucleon scattering. (auth)

13880 VECTOR-MESON INTERFERENCE IN $\pi^0\gamma$ PRODUCTION EXPERIMENTS. Greenhut, G.K. (Physics Department, Seton Hall University, South Orange, New Jersey 07079). Phys. Rev. D 9: No. 7, 1957-1963 (1 Apr 1974).

The presence of effects due to interference between ρ–ω and ρ–φ vector-meson production in $\pi^0\gamma$ production experiments is discussed. A comparison of photoproduction and colliding-beam mass sections will yield information on the relative phases of the vector-meson production amplitudes. (auth)

13881 HADRON PRODUCTION BY ELECTRON–POSITRON COLLIDING BEAMS. Terazawa, H. (The Rockefeller University, New York, New York 10021). Phys. Rev. D 9: No. 5, 1335-1340 (1 Mar 1974).

Various considerations and conjectures are made on the surprisingly large total cross section for hadron production which has recently been observed in the e^+-e^- colliding-beam experiment at the Cambridge Electron Accelerator. First, they focus on the relative magnitude of cross sections for one-photon annihilation and for the two-photon process. Second, the asymptotic limit R of the ratio $\sigma(e^+ + e^- \to \text{hadrons})/\sigma(e^+ + e^- \to \mu^+ + \mu^-)$ is predicted to be $R \simeq 12\pi^2(f_\rho^{-2} + f_\omega^{-2} + f_\phi^{-2}) \cong 5.5 \pm 0.7$ from the PCDC (partially conserved dilation current) anomaly and vector-meson dominance, and estimated to be less than 15 for $\Gamma(\epsilon \to \pi^+ + \pi^-) = 400$ MeV from the first evidence found at Frascati for hadron production by the two-photon process. A comment is also made on the present and future e^+-e^- colliding-beam experiments at SLAC and DESY. (auth)

13882 COMMENT ON THE PHOTOPRODUCTION OF THE ρ′ (1500). Ferbel, T.; Slattery, P. (Department of Physics and Astronomy, University of Rochester, Rochester, New York 14627). Phys. Rev. D 9: No. 3, 824-825 (1 Feb 1974).

The absence of a decay mode for the photoproduced ρ′ (1500) into two pseudoscalar mesons suggests a kinematic interpretation for the enhancement observed in the reaction $\gamma p \to \rho'(1500)p \to 2\pi^+ 2\pi^- p$ at 9.3 GeV/c. A naive Reggeized-Deck calculation satisfactorily describes the observed mass spectra. (auth)

13883 ASYMPTOTICALLY FREE GAUGE THEORIES. II. Gross, D.J.; Wilczek, F. (Joseph Henry Laboratories, Princeton University, Princeton, New Jersey 08540). Phys. Rev. D 9: No. 4, 980-993 (15 Feb 1974).

Deep-inelastic lepton-hadron scattering is analyzed in asymptotically free gauge theories of the strong interactions. The renormalization-group equations for the coefficients of the twist-two operators in the Wilson expansion are reviewed. A careful treatment of the mixing of operators with identical quantum numbers and dimensions is given. The relevant anomalous dimensions of the twist-two operators are calculated to second order in perturbation theory. These are used to calculate the asymptotic q^2 behavior of the moments of the structure functions. It is shown that the approach to the asymptotic limit is logarithmic, that Bjorken scaling is violated by powers of $\ln(-q^2)$, and that the naive light-cone or parton-model relations for the moments of the structure functions are true asymptotic theorems. A new sum rule for the first moment of F_2, in terms of the energy-momentum tensor, is derived. An example of a function, whose moments have roughly the correct asymptotic q^2 behavior, is constructed. The q^2 behavior of the structure functions for a given x is discussed. (auth)

13884 THEORY OF THE ELECTROMAGNETIC STRUCTURE FUNCTIONS OF THE PROTON. Baiquni, A.; Barut, A.O. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Rev. D 9: No. 4, 1084-1091 (15 Feb 1974).

The knowledge of the wave function of a relativistic composite system constitutes a complete description of its intrinsic properties such as mass spectrum, elastic and inelastic form factors, and structure functions. The wave functions of the proton obtained from the O(4,2) infinite-multiplet model, which were used previously to calculate mass spectra and form factors, are applied to reevaluate in a more complete manner the structure functions in closed form. The resultant scaling functions obey the Drell-Yan relation $F_2(\xi) \sim (1-\xi)^3$ and, under certain conditions, the Callan-Cross relation $F_2(\xi) \approx 2\xi F_1(\xi)$. (auth)

13885 COMPTON SCATTERING IN EXTERNAL MAGNETIC FIELDS: SPIN-ZERO CHARGED PARTICLES. DeRaad, L.L., Jr.; Dass, N.D.H.; Milton, K.A. (Department of Physics, University of California, Los Angeles, California 90024). Phys. Rev. D 9: No. 4, 1041-1053 (15 Feb 1974).

Methods recently developed by Schwinger are applied to derive a general expression for the total spin-0 unpolarized Compton cross section in the presence of an arbitrarily strong homogeneous external magnetic field. This expression is correct to order α^2 in radiative effects, but treats the external field exactly. The motion of the incident photon is restricted to lie along the field direction. Special limiting cases corresponding to classical and weak-field limits are discussed. (auth)

13886 QUANTIZING RELATIVISTIC ACTION-AT-A-DISTANCE MECHANICS. Kracklauer, A. F. Houston, TX; Univ. of Houston (1973). 97p. University Microfilms Order No. 74-11,830.

Thesis (Ph. D.).

A wave equation for charged particles whose nonquantal dynamics is regulated by a relativistic action-at-a-distance formulation of dynamics is presented. Resolutions are given for what has heretofore been the two principle obstacles to construction of such an equation. One, a quantization procedure is developed on the epistemological foundation afforded by regarding the wave aspect of deBroglie's second solution as a manifestation of a classical electromagnetic background with a Lorentz invariant energy spectral density. Such a procedure does not give time a special status and is therefore applicable directly to any formulation of dynamics. Two, a single parameter Lagrangian is proposed which leads to equations of motion free of certain difficulties endemic to the Fokker formulation of relativistic action-at-a-distance dynamics. Finally, comments are made regarding the possible physical and philosophical impact of these resolutions and the resulting wave equation. (Diss. Abstr. Int., B)

13887 RADIATIVE CORRECTIONS TO μ-DECAY IN THE SO(3) GAUGE MODEL. Hagiwara, T. Stony Brook, NY; State University of New York (1973). 86p. University Microfilms Order No. 74-6755.

Thesis (Ph. D.).

A renormalization program is presented for the spontaneously broken gauge theory in the generalized R_η-formalism, particularly by examining the radiative corrections to μ-decay and β-decay in the SO(3) model. By actual calculation it is proven that the theory yields a gauge-independent S-matrix when all the contributions are summed up. Also it is shown how to treat the infrared problem associated with a zero mass photon in a gauge theory by introducing an infinitesimally small mass to a photon without destroying a renormalizability of the theory. The renormalization program was carried out in the Landau-gauge. The physical quantities up to the order of $G_F^2\alpha$ were calculated and it was found that the ratio of the μ-decay and β-decay coupling constants is dependent on the fermion mass spectra in the SO(3) model. (Diss. Abstr. Int., B)

13888 UPPER BOUND ON THE TWO-PHOTON EXCHANGE AMPLITUDE FOR ELECTRON-PROTON ELASTIC SCATTERING. Perisho, R. C. New Haven, CT; Yale Univ. (1973). 184p. University Microfilms Order No. 74-11,626.

Thesis (Ph. D.).

Electron-proton elastic scattering data is consistent with a single photon exchange. However, the possibility exists that two (or more) photon exchange may become significant at higher energies or higher momentum transfer. The imaginary part of the two-photon exchange amplitude is equal to an integral over one-photon exchange inelastic scattering amplitudes by a generalized optical theorem. This can be converted, by a Schwarz inequality, to an inequality involving integrals over inelastic cross sections. This bound was calculated over a large range of energies and momentum transfers using experimental data and theoretical models for the inelastic cross sections. A dispersion relation which estimates a bound on the real part of the two-photon exchange amplitude was carried out. Bounds on the experimentally observable recoil proton polarization and e^+p-e^-p asymmetry are calculated. These bounds are the same order of magnitude as current experimental bounds, where they exist, but they become quite large at higher energy and momentum transfer. The significance of saturation of this bound is discussed, and estimated how much too high it may be. It is concluded that two-photon exchange effects may be observable at experimentally accessible kinematics. (Diss. Abstr. Int., B.)

13889 SCALING, LIGHT-CONE STRUCTURE AND PARTON MODEL IN DEEP INELASTIC ELECTRON-PROTON SCATTERING. Bhaumik, D. College Park, MD; Univ. of Maryland (1973). 95p. University Microfilms Order No. 74-9781.

Thesis (Ph. D.).

The parton model is modified by allowing the parton mass to change after absorbing the space-like photon. Each prescription for the intermediate state parton mass leads to a model with a definite scaling variable and to a scale-breaking factor which describes the approach to scaling. The model with Bloom, et al., variable ω' has the required linear zero at $Q^2 = 0$ in νW_2, and has a scale-breaking factor which agrees with experiment for $1 \le \omega' \le 12$. The prescription that the parton mass vanish after absorbing the photon leads to the scaling variable $\bar{\omega}$ which also occurs in the light cone singularity dominance model. Models which allow agreement of the sum rule for the mean squared charge per parton with experiment are given, as are models which have diffractive behavior for Q^2 near zero. Light-cone singularities in the current commutator matrix element of the nucleon, and scaling behavior of the structure function, are characterized in terms of the singularities of the Mellin transform $\hat{\phi}(u,s)$ of the relevant Jost-Lehmann weight. Absence of singularities in $\hat{\phi}(u,s)$ for Re $s \le 1$ is shown, under some assumptions, to characterize existence of the scaling limit. For Re $s < 2$, either the left-most singularity of $\hat{\phi}(u,s)$ in the s-plane or the canonical singularity at $s = 1$ determines both the leading light-cone singularity of the matrix element and the leading behavior, for large ν and Q^2 with fixed scaling variable, of the structure function. Thus the leading light-cone singularity dominates the leading behavior of the structure function regardless of the existence of the scaling limit. The Bjorken limit of structure functions with x-space singularities of the form $\epsilon(x^0)\delta^{(k)}(x^2-a^2)f(r)$ is considered for $a^2 > 0$ and for $a^2 = 0$, as point functions and as distributions. For $a^2 > 0$, the structure function is bounded as a point function by $C\, q^{-k-n/2+1/2}$, $q = (\nu^2 + Q^2)^{1/2}$ large, if $r^n f(r) \in L^2(0,\infty)$, for $a^2 = 0$ it is bounded by $C\, q^{k-1}$, independent of n. Considered as a distribution, the structure function is bounded by $C_j q^{-j}$ for all j for $a^2 > 0$; for $a^2 = 0$ the point function bounds remain relevant. (Diss. Abstr. Int., B)

13890 SELECTED TOPICS IN HIGH ENERGY PARTICLE PHYSICS. Sigaud Filho, C. New York; Syracuse Univ. (1973). 79p. University Microfilms Order No. 74-10,189.

Thesis (Ph. D.).

It is shown how Wanders sum rules for π-π low energy parameters are simple consequences of one of the Roy equations. This equation gives in addition, a new sum rule for the p wave effective range. It is also shown how to convert inequalities involving the d wave scattering length, the total cross section, and diffraction peak widths, into inequalities where these widths are eliminated. Furthermore, it is shown how superconvergence relations follow from that Roy equation if specific assumptions are made about the asymptotic behavior of the crossed t channel amplitude. Using π-π phase shift data from 500 to 1100 MeV, the low energy parameters; the I = 0 s wave scattering length is in marginal agreement with Weinberg's theoretical result, and the

I = 2 s wave scattering is an order of magnitude smaller. The consequences on the s wave scattering lengths due to arbitrary enhancements on the p wave I = 1 phase shift in rhe region below 500 MeV are also investigated. An upper bound for the pion charge radius is constructed using a dispersion relation derived by Balachandran and Loeffel. This dispersion relation is satisfied by form factors that have the exponential decrease suggested by Wu and Yang. The bound numerically is calculated using data from e-e colliding beam experiments, and it is in agreement with recent experimental results for the pion charge radius. Rigorous sets of unitarity bounds on moments of the absorptive parts of elastic scattering amplitudes and its derivatives with respect to the cosine of the scattering angle for pion-pion and pion-nuclear scattering are derived. These bounds are similar to unitarity bounds found by Singh and Roy for the absorptive parts and their derivatives in the physical scattering region only. (Diss. Abstr. Int., B)

13891 MODEL FOR FINAL-STATE INTERACTIONS IN PHOTOPRODUCTION OF π^0 ON DEUTERIUM IN THE $\Delta(1236)$-RESONANCE REGION. Jurewicz, A.; Satta, L. (CNEN, Frascati, Italy). Lett. Nuovo Cim.; 10: No. 6, 217-221(8 Jun 1974).

A study is made of possible corrections to the spectator model due to genuine final-state interactions. The differential cross section for the reaction $\gamma + d \rightarrow \pi^0 + p + n_s$ is studied. (JFP)

13892 NONRESONANT ASYMMETRY IN $e^+e^- \rightarrow \pi^+\pi^-$. Brown, R. W.; Mikaelian, K. O. (Case Western Reserve Univ., Cleveland). Lett. Nuovo Cim.; 10: No. 7, 305-312(15 Jun 1974).

Since higher-order radiative corrections in high energy pion reactions have not received much attention, the asymmetry in the differential cross sections for the reaction $e^+ + e^- \rightarrow \pi^+ + \pi^-$ is considered. (JFP)

13893 ORIGIN OF THE MAGNETIC FIELD. English, D. R. (Rhodes Univ., Grahamstown, South Africa). Lett. Nuovo Cim.; 10: No. 7, 286-288(15 Jun 1974).

In the discussion of origin of the magnetic field it is postulated that the permittivity of the vacuum is not invariant. From the discussion an explanation is given of the magnetic moment of the electron and other fundamental particles. (JFP)

13894 RENORMALIZED MODELS OF ELECTROMAGNETIC AND WEAK INTERACTIONS. Vainshtein, A. I.; Khriplovich, I. B. (Inst. of Nuclear Physics, Novosibirsk, USSR). Usp. Fiz. Nauk; 112: No. 4, 685-709(Apr 1974). (In Russian).

The renormalizability of different theories of vector fields is examined. The use of the renormalized theory in which the mass of the vector field appears because of the spontaneous breakdown of symmetry for the construction of a model of weak, electromagnetic, and strong interactions was discussed. Some specific schemes and experimental limitations on the parameters of these schemes were developed. (tr-auth)

13895 SYMMETRY OF HAMILTON–JACOBI AND KLEIN–GORDON EQUATIONS. Naiminov, A. L.; Shapovalov, V. N. (Kalmyk State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 4, 146-147(1974). (In Russian).

A controlling equation was constructed for the first integral and third order differential symmetry operator for classical and quantum equations, describing the motion of spinless charged particles in electromagnetic fields in the relativistic and steady nonrelativistic cases. (tr-auth)

13896 β DECAY OF NON-POLARIZED NEUTRONS IN INTENSE ELECTROMAGNETIC FIELDS. Baranov, I. G. (Nizhni Tagil Pedagogical Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 4, 115-120(1974). (In Russian).

The effect of an electromagnetic field with circular polarization on the β decay of neutrons was examined at the parameter values $ea/m \ll 1$ and $ea/m \sim 1$, where e and m are the charge and mass of the electron and a is the amplitude of the field potential. Within the framework of the V–A variant of the theory of weak interactions, in the first order perturbation theory, it was shown that with increase of the intensity of the field the probability of neutron decay is increased. Calculations were made of the nascent electrons at $ea/m = 0.5$ and $ea/m = 1$. The results obtained were discussed. (tr-auth)

13897 DETERMINATION OF THE ELECTROMAGNETIC TRANSITION FORM FACTORS FROM THE SCALING BEHAVIOR IN THE e–p SCATTERING. Tajima, T. (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 50: No. 5, 1653-1665(Nov 1973).

Explicit expressions of the electromagnetic form factors for the resonance production and sum rules for the transition magnetic moments are derived by requiring that the precocious scaling be reproduced in the direct channel resonance model for the e–p scattering. Using these results explicit forms of the structure functions W_1 and νW_2 are obtained in the scaling region, and $(d\sigma_{m1}/d\Omega)/(d\sigma_{e1}/d\Omega)$ and the radiative decay width Γ_γ of the nucleon resonance are calculated. (auth)

13898 FORMATION OF PRESET TRAJECTORIES OF CHARGED PARTICLES BY TWO-DIMENSIONAL ELECTROSTATIC FIELDS. Bondarenko, P. S.; Trandash, M. M. (Kiev Maintained Univ.). Dopov. Akad. Nauk Ukr. RSR, Ser. A; No. 4, 291-293(Apr 1974). (In Ukrainian).

Necessary and sufficient conditions are obtained for the family of curves which make it possible to represent a family of trajectories of charged particles in a two-dimensional electronic field. The method is proposed to find the forming field. Examples are available. (auth)

13899 HOW DOES TRIPLE-POMERANCHUKON COUPLING MODIFY $F_2(\omega)$? Ezawa, Z.F.; Maharana, J. (Department of Physics, University of Tokyo, Tokyo, Japan). Phys. Rev. D 9: No. 7, 2164-2166 (1 Apr 1974).

The deep-inelastic electroproduction process is studied in the presence of high-mass diffractive dissociation. The first-order correction, in triple-Pomeranchukon coupling, to the structure function $F_2(\omega)$ is explicitly calculated as $\delta F_2(\omega) = 0.013 \ln\omega$ and $\delta F_2(\omega) = 0.11 \ln(1 + 0.11 \ln\omega)$ for large ω, corresponding to $\alpha_{\mathbb{P}} = 0$ and $\alpha_{\mathbb{P}} = 0.25$ GeV^{-2}, respectively. It is also shown that the diffractive peak of the inclusive cross section for $e(\mu) + p \rightarrow e'(\mu') + p' + X$ is completely fixed by available parameters from $p + p' \rightarrow p'' + X$ and electroproduction structure functions. (auth)

13900 USE OF A MODIFIED WOODS-SAXON POTENTIAL BETWEEN A QUARK AND A DIQUARK. Ono, S. (Department of Physics, University of Tokyo, Tokyo, Japan). Phys. Rev. D 9: No. 7, 2005-2016 (1 Apr 1974).

The electroproduction processes $ep \rightarrow eN^*$ have been studied extensively in nonrelativistic quark models by many authors. But none of these results is in complete agreement with experimental data. In this note we will show that if a modified Woods-Saxon potential $-V_0[r/b+1]/\{r/b+e^{(r-R)/a}\}$ is used between a quark and a diquark, then predictions of the two-body baryon model proposed by the present author agree with the experimental data on the cross sections for the elastic and electroproduction processes of the first, second, and third resonances. (auth)

13901 PION ELECTROMAGNETIC FORM FACTOR—DATA ANALYSIS AND ASYMPTOTIC BEHAVIOR. Deo, B.B.; Parida, M.K. (Physics Department, Utkal University, Bhubaneswar, Orissa, India). Phys. Rev. D 9: No. 7, 2068-2077 (1 Apr 1974).

Existing data on the pion form factor are analyzed with a view to suggesting a method of verifying theoretical predictions about its asymptotic behavior. A Broadhurst-type analysis gives a falloff faster than $(\ln t)^c/t^{(p+1)/2}$ for $t \rightarrow \infty$, where p is the exponent of the threshold factor of the structure function νW_2. Most of the dynamical models predict an asymptotic decrease $(\ln t)^{2m}/t^n$ with m and n as integers. For data analysis a G/D method is developed and parametrized, the D function possessing the analyticity property due to the two-body elastic cut and the G function possessing the inelastic cut and the ρ–ω interference term. The logarithms occur naturally in a conformally mapped parabolic variable which is used to parametrize the G function. An analysis of the available data yields the results that although a $1/t^2$ or $(\ln t)^2/t^2$ type of behavior is not ruled out, the best fit is given for $c \geq 0$ and $p = 5$, suggesting a $1/t^3$ behavior. We also obtain the results (I) $r_\pi = (0.70 \pm 0.01)$ fm for the pion's electromagnetic radius and (II) $\xi = (0.0094^{+0.0008}_{-0.0001}) \times \exp i(101^{\circ}{}^{+2^{\circ}}_{-3^{\circ}})$ for the ρ–ω interference amplitude and phase. (auth)

13902 COMMENT ON THE SHRINKAGE OF POMERON EXCHANGE IN ϕ^0-MESON PHOTOPRODUCTION. Eisenberg, Y. (Weizmann Institute, Rehovot, Israel). Phys. Rev. D 9: No. 7, 2187-2189 (1 Apr 1974).

The question of shrinkage of the forward $d\sigma/dt$ slope in ϕ^0 photoproduction is examined by ultilizing K^+p, K^-p, and π^-p total cross sections and the quark-model relations. It is shown that existing data agree more or less with forward shrinkage, if $d\sigma/dt$ is expressed by $A\exp(Bt + Ct^2)$ in the $|t|$ range 0–0.6 GeV^2. (auth)

13903 PRONG INEQUALITIES FOR $e^+e^- \rightarrow \gamma \rightarrow N\pi$. Pais, A. (Rockefeller University, New York, New York 10021). Phys. Rev. Lett. 32: No. 19, 1081-1083 (13 May 1974).

I consider the ratio of the total cross section for $e^+e^- \rightarrow \gamma \rightarrow N\pi$ with 2p visible prongs to that with two visible prongs. For any fixed N and all p, nontrivial and optimal lower isospin bounds are derived for these ratios. The preliminary data indicate that these bounds may be experimentally significant. (auth)

13904 PROTON-NEUTRON MASS DIFFERENCE AND THE PION MASS IN A GAUGE MODEL. Lieberman, J. (Rockefeller

University, New York, New York 10021). Phys. Rev. D 9: No. 6, 1749-1761 (15 Mar 1974).

In a variation of the Weinberg SU(2) ×SU(2) ×U(1) gauge model of the weak and electromagnetic interactions, we study the proton–neutron mass difference, which is calculable, and investigate the appearance of pions as part of the Higgs system. We find that the proton–neutron mass difference is a function of the way in which the symmetry is broken. We exhibit a possible symmetry breaking which produces the correct sign for the mass difference. In the Higgs sector, we have a mass-degenerate pseudoscalar triplet which interacts with nucleons as pions do in the SU(2) ×SU(2) σ model. Therefore we identify this triplet with pions. They are massive in zeroth order, but we can calculate the mass difference δm^2. We find that δm^2 is of order $\alpha\mu^2$ which is too large. If we impose a reflection symmetry on the Lagrangian, the symmetry group of the potential is enlarged and we find that the theory contains three pseudo–Goldstone bosons. These are the pion triplet, which are now massless in zeroth order. When we calculate the pion mass in the one–loop approximation, the Π^0 remains massless while the charged pions pick up mass of order $m^2 \sim \alpha\mu^2$. This may perhaps be damped numerically to give a suitable estimate of the pion mass, but the mass difference is still too large. (auth)

13905 MASSIVE QUARKS AND THE QUARK–PARTON MODEL. Sanda, A.I. (National Accelerator Laboratory, Batavia, Illinois 60510). Phys. Rev. D 9: No. 6, 1785-1788 (15 Mar 1974).

The parton–model result $\nu W_2(x) = \Sigma_i e_k{}^2 f_i(x)$ is derived for massive quarks in the case where partons are identified as quarks. A simple model of a bound–quark system is also given in order to illuminate the ideas behind the derivation. (auth)

13906 ELECTROMAGNETIC MASS DIFFERENCE OF VECTOR MESONS. Brown, L.M. (Instituto de Física, Universidade de São Paulo, São Paulo 8.219, Brazil); Mich, J.D. Phys. Rev. D 9: No. 6, 1779-1784 (15 Mar 1974).

We discuss an effective Lagrangian model of vector mesons interacting with themselves and photons, which yields finite lowest–order dynamical electromagnetic corrections to the vector–meson masses. The strong–interaction part of the Lagrangian is given by a renormalizable model of 't Hooft, based on massless Yang–Mills fields which acquire mass by the Higgs–Kibble mechanism. The relationship of this vector field to the usual massive Yang–Mills field and of our electromagnetic interaction to that of Kroll, Lee, and Zumino is discussed in the light of a suggestion made by Lee and Zinn–Justin that the renormalizable vector field may be a regularized version of the usual massive vector field. The mass shifts of the charged and neutral ρ mesons are found to be small and nearly equal, well within present experimental uncertainties in the ρ–meson masses. (auth)

13907 TIME–DEPENDENT MULTICHANNEL COULOMB SCATTERING THEORY. Chandler, C.; Gibson, A. G. (Univ. of New Mexico, Albuquerque). J. Math. Phys. (N. Y.); 15: No. 3, 291-294(Mar 1974).

The formulation by Mulherin and Zinnes of two-particle Coulomb scattering theory is extended to the multichannel case. The wave operators so obtained are proved by a direct method to be identical with those of Dollard. (auth)

13908 REMARKS ON VANISHING LONGITUDINAL CROSS SECTIONS AND OPERATOR SCHWINGER TERMS. Taha, M.O. (Department of Physics, University of Khartoum, Khartoum, Sudan). Phys. Rev. D 9: No. 2, 515-516 (15 Jan 1974).

We show that a vanishing total cross section $\sigma_L(\nu, q^2)$ for virtual photons is not compatible with the presence of operator for Schwinger terms in the proton–proton matrix element of the equal–time electromagnetic commutator if νW_2 scales. (auth)

13909 RADIATIVE CORRECTIONS TO THE LOW–ENERGY THEOREM FOR $\pi^0 \to \gamma\gamma$ IN A NON-ABELIAN GAUGE THEORY. Chanowitz, M.S. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). Phys. Rev. D 9: No. 2, 503-507 (15 Jan 1974).

We investigate a class of possible radiative corrections to the low–energy theorem for $\pi^0 \to \gamma\gamma$ in theories with massive charged vector mesons. The absence of these corrections is verified to fourth order in a spontaneously broken, non–Abelian gauge model. (auth)

13910 HYPERSPHERICAL APPROACH TO QUANTUM ELECTRODYNAMICS: SIXTH–ORDER MAGNETIC MOMENT. Levine, M.J. (Department of Physics, Carnegie–Mellon University, Pittsburgh, Pennsylvania 15213); Roskies, R. Phys. Rev. D 9: No. 2, 421-429 (15 Jan 1974).

We present the details of a powerful new technique used in an exact calculation of the contribution of 6 sixth-order vertex graphs to the anomalous magnetic moment of the electron. By introducing four–dimensional spherical coordinates, the momentum–space integrals can be evaluated directly. The angular integrations are performed using some simple properties of the Gegenbauer polynomials. For these graphs, the remaining convergent integrals are treated separately to extract all terms which do not vanish in the infrared and ultraviolet limits. The actual processing of the many terms involved was done using the algebraic computer program ASHMEDAL. (auth)

13911 ELECTROMAGNETIC MASS DIFFERENCES, THE PION MASS, AND THE ρ-A_1 MASS SPLITTING. Fujikawa, K. (Department of Applied Mathematics and Theoretical Physics, University of Cambridge, England); O'Donnell, P.J. Phys. Rev. D 9: No. 2, 461-471 (15 Jan 1974).

We discuss several problems related to the particle mass and mass differences in the framework of renormalizable gauge theories. We first explicitly calculate the hard–pion and the ρ–meson electromagnetic mass differences based on the chiral SU(2) ×SU(2) gauge model of Bardakci. In both cases the neutral particles receive infinite mass shifts, thus rendering the mass differences finite. This is compared with the Schwinger–Yan approach and with the recently proposed model for electromagnetic form factors and the ρ′ meson. We also estimate the effects of the ρ′ meson on the pion mass based on the soft–pion method and field algebra. We then attempt to obtain the small pion mass by means of an approximate algebraic realization of the chiral symmetry at high energies using a generalization of the Bardakci model. We also discuss the effects of heavier vector and axial–vector mesons on the ρ and A_1 mass splitting. It is shown that heavier mesons help to preserve the ρ–meson universality. (auth)

13912 ELECTROPRODUCTION SCALING IN AN ASYMPTOTICALLY FREE THEORY OF STRONG INTERACTIONS. Georgi, H.; Politzer, H.D. (Lyman Laboratory, Harvard University, Cambridge, Massachusetts 02138). Phys. Rev. D 9: No. 2, 416-420 (15 Jan 1974).

We analyze electroproduction in a non–Abelian gauge model of the strong interactions using the techniques of Christ, Hasslacher and Mueller. The theory is asymptotically free and consistent with scaling up to logarithms. All logarithmic factors appear as inverse powers of $\ln(-q^2)$ and hence vanish as $-q^2 \to \infty$. When $-q^2$ gets very large, the structure functions become strongly peaked near $x = 0$, and as $-q^2 \to \infty$ approach the singular scaling functions $2 \times F_1(x) = F_2(x) = a\delta(x)$, where the constant a is determined. In a strong–interaction model based on the gauge group SU(3) with three triplets of fractionally charged quarks, a equals 0.16. (auth)

13913 e^+e^-–γ– FOUR MESONS AND THE THREE MESONS IN A FERMION–LOOP MODEL. Wong, T.F. (Department of Physics, Rutgers, The State University, New Brunswick, New Jersey 08903). Phys. Rev. D 9: No. 9, 2646-2650 (1 May 1974).

The low–energy limit of the single–fermion–loop contribution to the reactions $e^+e^- \to \gamma \to \pi^+\pi^-\pi^0$, $K^+K^-\pi^0$, $\pi^+\pi^-\pi^0\pi^0$, $\pi^+\pi^-\pi^+\pi^-$, $K^+K^-\pi^0\pi^0$, and $K^+K^-K^+K^-$ were calculated without any adjustable parameters. Results were found to be comparable to recent experiments. This model's significance and its possible modification were discussed. (auth)

13914 DIFFRACTIVE BEHAVIOR OF DEEP–INELASTIC ELECTROPRODUCTION IN A RESONANCE MODEL. Dominguez, C.A.; Moreno, H. (Departamento de Física, Centro de Investigacion y de Estudios y Avanzados del Instituto Politécnico Nacional, Apartado Postal 14-740 Mexico 14, D. F.). Phys. Rev. D 9: No. 9, 2584-2591 (1 May 1974).

The diffractivelike as well as the nondiffractive behavior of the structure functions of the nucleons is explained in terms of a resonance model in which not all the form factors have the same Q^2 dependence. The most important results of such a model are the following: (i) νW_2 tends to a constant in the Bjorken limit as $\omega' \to \omega \to \infty$. (ii) For $\omega' \to 1$ the Drell–Yan–West relation is obtained. (iii) The difference between proton and neutron structure functions, as well as their ratio, can be properly explained. (iv) For ν and Q^2 large but finite νW^2 falls like $1/\omega$ for large w'. (v) The model has only two parameters to account for F_{2p}, F_{2p}–F_{2n}, and F_{2n}/F_{2p}. A very good agreement with present experimental data is obtained in all three cases. (vi) A breakdown of scaling is predicted for any finite energy, though in the Bjorken limit the structure functions do scale. (auth)

13915 CHARGE FLUCTUATIONS IN e^+e^- ANNIHILATIONS. Newmeyer, J.L.; Sivers, D. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). Phys. Rev. D 9: No. 9, 2592-2602 (1 May 1974).

We consider what can be learned about the nature of the annihilation process $e^+e^- \to$ hadrons from the measurement of the mean–square charge transfer between right and left c.m. hemispheres. Predictions of parton models, where this quantity goes to a finite constant, and fireball models, where it grows with multiplicity, are compared. We conclude that it should be possible to discriminate between these two classes of models at SPEAR energies. We also comment on difficulties associated with testing in e^+e^- annihilations Feynman's conjecture that quark quantum numbers remain in the parton fragmentation region. (auth)

13916 EXACT SUM RULES FOR THE DECAY CONSTANT OF THE NEUTRAL PION. Roy, P. (Tata Institute of Fundamental Research, Bombay-5, India). Phys. Rev. D 9: No. 9, 2631-2635 (1 May 1974).

Two new sum rules are obtained from fairly general assumptions. They relate the π^0 decay-constant to appropriate energy-integrals of the differences between the total hadronic production cross sections of two real photons (i) of equal and opposite helicities and (ii) of parallel and perpendicular linear polarizations. The sum rules are derived by both dispersion-theoretic and light-plane methods. The experimental verification of these sum rules will be possible in the near future by studying the reaction $ee \to (ee\gamma\gamma) \to ee$ + "anything hadronic" with polarized colliding beams in storage rings. Theoretical and experimental aspects of these questions are discussed. (auth)

13917 THRESHOLD CONNECTION BETWEEN SEMI-INCLUSIVE DEEP ELECTROPRODUCTION AND ANNIHILATION. Gatto, R. (Istituto di Fisica dell'Università, Roma, Italy and Istituto Nazionale di Fisica Nucleare, Sezione di Roma, Italy); Vendramin, I. Phys. Rev. D 9: No. 9, 2684-2688 (1 May 1974).

A unified discussion is given of the scaling limit for one-particle inclusive electroproduction, $e + p \to e +$ hadron + anything, and for its crossed reactions such as $e^+ + e \to \bar{p}$ + hadron + anything, $p +$ hadron $\to e^+ + e +$ anything, etc. General threshold relations, which hold also in absence of analytic continuation across the kinematical thresholds, are derived, generalizing previous results for the scaling functions of deep-inelastic scattering and annihilation. (auth)

13918 GENERALIZATION OF SCHROEDINGER'S WAVE MECHANICS FOR RELATIVISTIC REGIONS OF VALIDITY. Kasper, E. (Univ., Tuebingen, Ger.). Z. Naturforsch.; 28a: No. 2, 216-221(Feb 1973). (In German).

A scalar wave equation is derived to be applied to the relativistic motion of charged particles in slowly varying electromagnetic fields and which is valid in a sufficiently small energy interval, if spin effects can be neglected. Since this wave equation is a linear partial differential equation of first order in the time derivative but of second order in the space derivatives, it is not relativistically invariant. But it is possible to define a positively definite particle density from which a conservation law can be derived. The main success of this theory is a very simple generalization of the Schroedinger theory of classical wave mechanics in such a way that it can be also applied to relativistic particles. (GE)

Weak

Refer also to abstract 14423.

13919 (COO-2114-10) NEW DEVELOPMENTS IN THE K_S DECAY PARAMETERS AND THE CP VIOLATION PARAMETERS IN THE K_L SYSTEM. Nauenberg, U. (Colorado Univ., Boulder (USA). Dept. of Physics and Astrophysics). 1973. Contract AT(11-1)-2114. 18p. Dep. NTIS $4.00.

A review is given of what has happened, and a reanalysis of the state of the various parameters that describe the K_S and K_L decays is made. The lifetime, branching ratio, and the $\Delta I = 1/2$ and $3/2$ amplitude in the decays are discussed. (JFP)

13920 (NAL-CONF-74-39-THY) ACCELERATOR NEUTRINO PHYSICS, PRESENT AND FUTURE: A REVIEW FOR THEORISTS AND EXPERIMENTALISTS. Adler, S. L. (Institute for Advanced Study, Princeton, N. J. (USA)). 1974. 58p. (CONF-740334-1). Dep. NTIS $6.00.

From topical conference on neutrino physics; Batavia, Illinois, USA (29 Mar 1974).

The review covers the kinematics and review of standard V-A theory, lepton conservation results, exclusive and inclusive reactions, the quark-parton model, scaling breakdown, problems with high energy and higher-order weak interactions, review of gauge theories, and tests of gauge theories. (JFP)

13921 (NAL-CONF-74-43-THY) NOTES ON CHARMED PARTICLE SEARCHES IN NEUTRINO EXPERIMENTS. Gaillard, M. K. (National Accelerator Lab., Batavia, Ill. (USA)). Apr 1974. 11p. (CONF-740418-1). Dep. NTIS $4.00.

From fourth international conference on neutrino physics and astrophysics; Philadelphia, Pennsylvania, USA (26 Apr 1974).

The discussion covers charm, masses of charmed particles, threshold effects, the Adler sum rule, production of charmed particles in neutrino experiments, the optimistic assumption $F_3 \neq 0$, strangeness-changing events, the lepton branching ratio, and a summary of signatures. (JFP)

13922 (NP-20028) CABIBBO UNIVERSALITY, RENORMALIZATION AND THE Z VECTOR BOSON MASS. Roos, M. (Helsinki Univ. (Finland). Dept. of Nuclear Physics). 11 Dec 1973. 17p. Dep. NTIS $4.00.

Using the most recent data on the ft-values of the $0^+ \to 0^+$ decays ^{14}O, ^{26m}Al, and ^{34}Cl, the hyperon β-decays, and the $K^+_{\ell 3}$ rate, the following limits (95% confidence level) are determined: Cabibbo angle $\sin\theta > 0.226$, intermediate vector boson mass $M_z > 25$ GeV (for four quarks with integral charges) or $M_z > 110$ GeV (three colored quartets), $K^+_{\ell 3}$ form factor $f_+(0) < 0.98$. (auth)

13923 COHERENT EFFECTS OF A WEAK NEUTRAL CURRENT. Freedman, D.Z. (National Accelerator Laboratory, Batavia, Illinois 60439). Phys. Rev. D 9: No. 5, 1389-1392 (1 Mar 1974).

If there is a weak neutral current, then the elastic scattering process $\nu + A \to \nu + A$ should have a sharp coherent forward peak just as $e + A \to e + A$ does. Experiments to observe this peak can give important information on the isospin structure of the neutral current. The experiments are very difficult, although the estimated cross sections (about 10^{-38} cm^2 on carbon) are favorable. The coherent cross sections (in contrast to incoherent) are almost energy-independent. Therefore, energies as low as 100 MeV may be suitable. Quasi-coherent nuclear excitation processes $\nu + A \to \nu + A^*$ provide possible tests of the conservation of the weak neutral current. Because of strong coherent effects at very low energies, the nuclear elastic scattering process may be important in inhibiting cooling by neutrino emission in stellar collapse and neutron stars. (auth)

13924 COINCIDENCE HADRON PRODUCTION IN NEUTRINO-INDUCED REACTIONS. Ahmed, M.A. (Department of Mathematics, University of Durham, Durham, England). Phys. Rev. D 9: No. 5, 1559-1568 (1 Mar 1974).

We discuss neutrino-induced reactions leading to a multiparticle hadronic final state from which only a single hadron is detected in coincidence with the outgoing lepton. A peripheral model for such processes is constructed and discussed in detail. Regge and scaling behaviours are studied and expressions for the structure functions and the hadronic density-matrix elements are obtained. (auth)

13925 WEAK NEUTRAL CURRENTS IN ELECTRON AND MUON SCATTERING. Berman, S.M. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305); Primack, J.R. Phys. Rev. D 9: No. 7, 2171-2173 (1 Apr 1974).

Contributions to inelastic scattering arising from the interference of a weak neutral current with the electromagnetic current are calculated using the Weinberg model and the quark-parton model. These interferences produce nonvanishing $(d\sigma - d\sigma^+)$, $(d\sigma^{(L)} - d\sigma^{+(R)})$, $(d\sigma^{(L)} - d\sigma^{(R)})$, which give rise to sizeable affects when compared to the purely electromagnetic scattering. (auth)

13926 WEAK INELASTIC PRODUCTION AND LEPTONIC DECAYS OF HEAVY LEPTONS. Soni, A. (Columbia University, New York, New York 10027). Phys. Rev. D 9: No. 7, 2092-2103 (1 Apr 1974).

We examine here reactions of the type

$$\nu(\bar{\nu}) N \to L^z + \text{"anything"} \quad \text{and} \quad l^z N \to \bar{L}^0 + \text{"anything"}$$
$$\nu(\bar{\nu}) + l^z + \nu_{l^z} \qquad\qquad l^z + l'^z + \nu_{l'^z},$$

where L is a lepton heavier than the muon, and derive expressions for the inclusive cross sections of the outgoing charged leptons. The phase-space integration is simplified by neglecting the electron and muon masses, and the differential cross sections, with respect to the transverse momentum of the charged leptons in the final state, are calculated. Using a simple to that of the muon. A simple relation between the differential cross section of the outgoing charged leptons along the beam axis and the total cross section is obtained. Throughout these calculations the effects produced on the spectrum of the final charged lepton by the polarization of the heavy lepton are fully incorporated. (auth)

13927 BOUNDS ON CHIRAL-SYMMETRY BREAKING AND K_{l3} SLOPE PARAMETERS. Prasad, S.C. (Department of Physics and Astronomy, University of Rochester, Rochester, New York 14627). Phys. Rev. D 9: No. 7, 2167-2170 (1 Apr 1974).

Using the rigorous bounds of Li and Pagels and Okubo and the broken SU(3) $\times$ SU(3) model of Glashow and Weinberg and Gell-Mann, Oakes, and Renner, we derive bounds on the symmetry-breaking parameters which measure the invariance of the Hamiltonian and the vacuum under SU(3). We also obtain bounds on λ_0, the slope of the spin-0 form factor in K_{l3} decay. Our bounds on λ_0, though inconsistent with the experimental value obtained by a quadratic fit to the K_{l3} form factors, are consistent with the value obtained by a linear fit. Some theoretical implications of our results are discussed. (auth)

13928 NUCLEAR CHARGE-EXCHANGE CORRECTIONS TO LEPTONIC PION PRODUCTION IN THE (3, 3) -RESONANCE

REGION. Adler, S.L. (Institute for Advanced Study, Princeton, New Jersey 08540); Nussinov, S.; Paschos, E.A. Phys. Rev. D 9: No. 7, 2125-2143 (1 Apr 1974).

We discuss nuclear charge-exchange corrections to leptonic pion production in the region of the (3, 3) resonance, both from a phenomenological viewpoint and from the evaluation of a detailed model for pion multiple scattering in the target nucleus. Using our analysis, we estimate the nuclear corrections needed to extract the ratio R $= [\sigma(\nu_\mu + n \to \nu_\mu + n + \pi^0) + \sigma(\nu_\mu + p \to \nu_\mu + p + \pi^0)]/2\sigma$ $(\nu_\mu + n \to \mu^- + p + \pi^0)$ from neutral-current search experiments using $_{13}Al^{27}$ and other nuclei as targets. (auth)

13929 WEAK NEUTRAL CURRENTS. Pais, A. (Rockefeller University, New York, New York 10021); Treiman, S.B. Phys. Rev. D 9: No. 5, 1459-1467 (1 Mar 1974).

Stimulated by recent indications that neutral-current effects may have been seen in high-energy neutrino reactions, we take up several issues that bear on the characterization of neutral hadron currents. Occasional guidance is sought in gauge models of the weak interactions, but the discussion is essentially phenomenological. Special emphasis is given to the question whether the neutral currents have "new" pieces, unrelated to those which appear in electromagnetism and in weak charge-changing reactions. Of particular interest here is the question: Are the neutral vector currents conserved? (auth)

13930 COMMENT ON A NEUTRINO SUM RULE. Zee, A. (The Rockefeller University, New York, New York 10021). Phys. Rev. D 9: No. 5, 1572-1574 (1 Mar 1974).

We show that a previously derived neutrino sum rule is in accord with present experiments. This suggests that charmed hadrons, if they exist at all, have not yet been produced. The validity of this sum rule is discussed. We show that there exists a relation involving only the isoscalar quantities $F_2^{\nu p} + F_2^{\nu n}$, $F_{2,3}^{\nu p} + F_{2,3}^{\nu n}$, and $F_{2,3}^{\nu p} + F_{2,3}^{\nu n}$ which would clearly reveal the charm, if any, of the weak-interaction current. (auth)

13931 $K^+ \to \pi^+\gamma\gamma$ DECAY IN A CURRENT-CURRENT QUARK MODEL AND A UNIFIED APPROACH TO WEAK RADIATIVE KAON DECAYS. Kamal, A.N. (Theoretical Physics Institute, Department of Physics, University of Alberta, Edmonton, Alberta, Canada). Phys. Rev. D 9: No. 3, 752-754 (1 Feb 1974).

$K^+ \to \pi^+\gamma\gamma$ decay as mediated by $H_w^{(\text{parity-violating})}$ is studied in a modified fermion-loop model. The effect of $H_w^{(p,v)}$ is stimulated by a phenomenologically constructed parity-violating meson-baryon-baryon interaction without introducing any new parameters. We find that the predicted branching ratio $r = \Gamma(K^+ \to \pi^+\gamma\gamma)/\Gamma(K^+ \to \text{all}) = 0.64 \times 10^{-6}$ is of the same order of magnitude as that of the tree-graph model of Moshe and Singer. (auth)

13932 CONSTRAINTS GIVEN BY THE ATMOSPHERIC NEUTRINO-INDUCED MUON FLUX ON THE NEUTRINO-NUCLEON INTERACTIONS AT HIGH ENERGIES. Kunszt, Z. (Joint Inst. for Nuclear Research, Dubna, USSR). Acta Phys. Acad. Sci. Hung.; 35: No. 1-4, 3-27(1974).

It is shown that from the measured neutrino-induced muon flux one can derive constraints on the neutrino-nucleon interactions at high energies. It is pointed out that if the structure functions in the deep-inelastic νN scattering exhibit scale invariant behavior, then the slope (c) of the total νN cross section ($\sigma = cE$) is necessarily less than 0.8 in agreement with predictions of gluon-quark parton models. If intermediate vector boson exists, then at 3 standard deviations $m_w > 2$ GeV. (auth)

13933 STRUCTURE OF THE CURRENT IN THE QUARTET SCHEME. Koike, K. (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 50: No. 5, 1692-1695(Nov 1973).

It is pointed out that there is a good correspondence between the structure of the weak current introduced on the basis of U(4) scheme and the one predicted by the Hiroshima model. (auth)

13934 WEAK MUON MAGNETIC MOMENT: A CAUSAL MASS-OPERATOR CALCULATION. Tsai, W.; DeRaad, L.L. Jr.; Milton, K.A. (Department of Physics, University of California, Los Angeles, California 90024). Phys. Rev. D 9: No. 6, 1840-1843 (15 Mar 1974).

The weak correction to the muon magnetic moment is calculated in Schwinger's model using the causal mass-operator technique. In the Feynman gauge we obtain the accepted result, while in the unitary gauge, a contact term is required by consistency. (auth)

13935 ATTEMPT TO GENERATE THE ANGLE BETWEEN THE STRONG AND WEAK INTERACTIONS. Zee, A. (Joseph Henry Laboratories, Princeton University, Princeton, New Jersey 08540). Phys. Rev. D 9: No. 6, 1772-1779 (15 Mar 1974).

We construct a toy gauge model in which the Cabibbo angle is generated by the effects of weak interactions. The model is so arranged that in the absence of the weak and electromagnetic interactions the N and λ quarks are both massless and degenerate with each other. The weak interaction splits this degeneracy and thus generates an angle between the strong and weak interactions. The value of the angle is determined in terms of certain parameters (experimentally measurable but unknown) that appear in the model. More interestingly, we abstract from this model the following statement: In the limit of vanishing Cabibbo angle, chiral symmetry becomes exact. It is argued that this statement holds for a large class of models. We suggest that in the real world this relation is also valid. A certain phenomenon involving CP violation and various options one may have in constructing a gauge theory including CP violation is discussed. (auth)

13936 SPONTANEOUS "CABIBBO" SUPPRESSION. Schechter, J.; Singer, M. (Physics Department, Syracuse University, Syracuse, New York 13210). Phys. Rev. D 9: No. 6, 1769-1771 (15 Mar 1974).

We demonstrate the possibility of a unified weak-electromagnetic gauge scheme in which the suppression of strangeness-changing weak amplitudes arises by spontaneous breakdown of an SU(3) symmetry. (auth)

13937 NEUTRAL CURRENT AND THE VALIDITY OF THE LOCAL THEORY OF THE WEAK INTERACTION. Ninomiya, M.; Watanabe, K. (Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto); 50: No. 6, 2097-2099(Dec 1973).

It was previously shown that upper bounds may be obtained for the weak boson and the cutoff which may be interpreted as the validity of the local theory of the weak interaction if the weak interactions is mediated by a charged weak boson. This method is applied to the case in which the weak interaction Hamiltonian H is local and is given in the form $H = G/\sqrt{2}\, J_\mu^+ J^\mu$, where J_μ is the Cabibbo current and G is the Fermi coupling constant. (JFP)

13938 S-MATRIX DERIVATION OF THE WEINBERG MODEL. Joglekar, S.D. (Institute for Theoretical Physics, State University of New York at Stony Brook, Stony Brook, New York 11790). Ann. Phys. (N.Y.) 83: No. 2, 427-448 (Apr 1974).

By applying only the requirement of asymptotic softness (i.e., the requirement that amplitudes should not grow, asymptotically, faster than that in a renormalizable theory) to various Born amplitudes with four external lines and making some specific assumptions about the number of added particles to meet the requirement, we obtain all of the interaction Lagrangian and relations among the masses and coupling constants of the Weinberg Model. (auth)

13939 PROOF OF THE WEINBERG SUM RULES IN THE BARS-HALPERN-YOSHIMURA MODEL. Danskin, H. (Lyman Laboratory of Physics, Harvard University, Cambridge, Massachusetts 02138). Phys. Rev. D 9: No. 8, 2364-2371 (15 Apr 1974).

Both sets of Weinberg spectral-function sum rules are proved in the context of the Bars-Halpern-Yoshimura model. We first discuss how to obtain the appropriate weak currents of the hadrons in such a gauge model, and then obtain the results by proving the equal-time commutation relations $[V^A{}_0, V^B{}_i] = [A^A{}_0, A^B{}_i]$, and $[\partial_0 V^A{}_i - \partial_i V^A{}_0, V^B{}_j] = [\partial_0 A^A{}_i - \partial_i A^A{}_0, A^B{}_j]$; the proof allows the spectral-function integrals involved to be different for the separate I-spin multiplets. (auth)

13940 FINITENESS OF RADIATIVE CORRECTIONS TO SEMILEPTONIC DECAYS IN UNIFIED GAUGE THEORIES. Mohapatra, R.N.; Sakakibara, S. (Centre for Theoretical Physics, Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). Phys. Rev. D 9: No. 2, 429-435 (15 Jan 1974).

Using current algebra and Bjorken-Johnson-Low techniques we exhibit the finiteness of second-order radiative corrections to strangeness-changing and strangeness-preserving semileptonic weak processes in the context of an $SU(2)_L \times U(1)$ gauge model (with the hadronic extension as suggested by Glashow, Iliopoulos, and Maiani) with strong interactions accounted for to all orders. (auth)

13941 MUONLESS NEUTRINO-INTERACTION EVENTS AND THE WEAK CURRENTS. Pakvasa, S.; Tuan, S.F. (Department of Physics and Astronomy, University of Hawaii, Honolulu, Hawaii 96822). Phys. Rev. D 9: No. 9, 2698-2700 (1 May 1974).

The baryon-current model of Sakurai for understanding neutral currents in weak interactions is extended to include $\Delta I = 1$ contribution and/or axial-vector terms in V - A form with the experimental implications spelled out. (auth)

13942 ARE SECOND-CLASS CURRENTS PRESENT IN HYPERON BETA DECAY?. Eimerl, D. (Department of Physics, University of California, San Diego, La Jolla, California 92037). Phys. Rev. D 9: No. 9, 2650-2658 (1 May 1974).

Within the framework of Cabibbo V-A theory bounds are obtained on the pseudotensor form factor which is induced by SU(3) violations. Such an estimate is necessary to distinguish second-class effects from effects of SU(3) violations. It is argued that calculations based on an

analogy with the dispersion-theory evaluation of the nucleon anomalous magnetic moment are suspect since the vector and axial-vector currents have very different structures. A different dispersion-theory calculation involving only the matrix elements of the axial-vector currents is presented, which predicts the F/D ratio of the pion-nucleon octet coupling to be $\pm (5/9)^{1/2}$. It is concluded that, if the controversial large experimental value of this is confirmed, this would then require the presence of a second-class current. (auth)

Strong (General)

Refer also to abstracts 14052 and 14060.

13943 (COO-1545-140) IS THE POMERON A GOLDSTONE BOSON? Pinsky, S. S.; Rabl, V. (Ohio State Univ., Columbus (USA). Dept. of Physics). 1974. Contract AT(11-1)-1545. 12p. Dep. NTIS $4.00.

A Reggeon field theory is proposed using as an input two exchange degenerate meson-like trajectories, each of them corresponding to a pair of conjugate poles. A Pomeron and a lower-lying Reggeon are generated by spontaneous symmetry breaking. Both the input and output trajectories have a $\sqrt{t}$ dependence and are complex for $t < 0$ reflecting the conventional treatment of Regge pole-cut collisions. The gauge symmetry of the model is briefly discussed, and the model is compared with earlier work. (auth)

13944 (NP-20032) CONSTITUENTS IN HADRONS WITH A SPECIFIC SU(3) STRUCTURE CAN GIVE NEW PREDICTIONS IN AGREEMENT WITH DATA. Toernqvist, N. A. (Helsinki Univ. (Finland). Research Inst. for Theoretical Physics). 1974. 11p. Dep. NTIS (US Sales Only) $4.00.

In search for a model, which can predict saturation of isospin bounds, often found in experimental data, a model is constructed for the hadrons and their interactions. The hadrons are composed of "core" and of "valence" constituents and hadron-hadron non-diffractive amplitudes are built from a product of a very strong global symmetric core-core interaction and a weaker SU(3) dependent valence-valence interaction. (auth)

13945 CAN MUELLER-REGGE MODELS DESCRIBE INCLUSIVE DATA CONSISTENTLY? Pinsky, S.S. (High Energy Physics Division, Argonne National Laboratory, Argonne, Illinois 60439); Thomas, G.H. Phys. Rev. D 9: No. 5, 1350-1364 (1 Mar 1974).

An attempt is made to understand, both phenomenologically and theoretically, the details of inclusive processes. A complete phenomenological analysis of all inclusive pion data in the central region is presented (in the context of the Mueller-Regge picture with three trajectories P, ρ, and f). Particular attention is paid to the constraints of charge conjugation and the approach to scaling. All the data are found to fit quite well, including two-body correlations, which have been in considerable variance in previous treatments. One consequence is the prediction that $\pi\pi$ correlations scale from above. At NAL energies, the nonscaling part is found to be large. The constraint on the couplings (γ) imposed by charge conservation, $\gamma^{pp} = 4(\gamma^{p\rho})^2/(a_\rho - a_p)$, is satisfied. In addition, a number of couplings are found to be approximately exchange-degenerate. Based upon the phenomenological indications, we try to construct the simplest possible Mueller-Regge model with three trajectories obeying the constraints of charge conservation and with and exchange-degenerate ρ and f. It is found that it is not possible to consistently construct such a model without adding additional physical mechanisms such as narrow-width resonances. Nevertheless, a model satisfying the above constraints without an exchange-degenerate ρ and f can be constructed and has many interesting properties that are borne out by the data. In the calculation of this model, extensive use is made of the recently proven equivalence of the Mueller-Regge and multiperipheral models. (auth)

13946 LIGHT-QUARK HADRON SPECTROSCOPY: EXPERIMENTAL SYSTEMATICS AND ANGULAR MOMENTUM SYSTEMATICS. Mac Gregor, M.H. (Lawrence Livermore Laboratory, Livermore, California 94550). Phys. Rev. D 9: No. 5, 1259-1329 (1 Mar 1974).

Quark-model systematics and experimental hadron systematics both indicate that quarks are light, with small binding energies. The assumption of small binding energies leads to two types of quark: (1) a 330-MeV spin-1/2 quark, the spinor S, which is required to reproduce the nucleon; (2) a 70-MeV spinless quark, the quantum M, which is required to reproduce the pion. It is shown that S and M, in suitable combinations, constitute a complete set of hadronic basis states, with quark and antiquark binding energies accurately mirroring nucleon and antinucleon binding energies. An extension of the equations of special relativity to include spinning masses establishes a phenomenological mass relationship between M and S, and it also relates M to the μ meson. With the aid of this light-quark basis set, the total angular momentum $\vec{J}$ of a hadron resonance can be separated into spin $\vec{S}$ and orbital $\vec{L}$ components. This separation is facilitated by the phenomenology of resonance widths: rotationless resonances ($L=0$) have narrow widths ($\Gamma < 50$ MeV), and rotational levels ($L>0$) have broad widths ($\Gamma \sim 100$ MeV). An experimental compilation of about 130 low-mass hadron resonances is presented and documented. These resonances can be grouped into rotational bands, as in nuclear physics, but the rotational bands are severely limited by the requirements of special relativity. The rotational bands give a reasonably complete and accurate mapping of the experimental resonances. Predictive successes of this light-quark model are summarized. Another paper gives in detail the systematics of light-quark binding energies, electromagnetic effects, geometries, and strangeness quantum numbers. (auth)

13947 RISING PLATEAU AND THE PERTURBATIVE TREATMENT OF HIGH-ENERGY INCLUSIVE REACTIONS. Tan, C.-I.; Tow, D.M. (Department of Physics, Brown University, Providence, Rhode Island 02912). Phys. Rev. D 9: No. 7, 2176-2179 (1 Apr 1974).

The perturbative treatment of high-energy hadronic reactions is applied to study inclusive reactions. Production of NN and/or diffractive dissociation into high mass are found to give rise to a plateau whose height rises like ln s. Methods are proposed to differentiate these rising mechanisms from the traditional one. Implications for inclusive phenomenology are discussed. (auth)

13948 GENERAL FORMULATION OF PIONIC DECAYS IN THE QUARK MODEL. Lipkin, H.J. (National Accelerator Laboratory, Batavia, Illinois 60510). Phys. Rev. D 9: No. 5, 1579-1583 (1 Mar 1974).

Predictions for pionic decays of resonances to states in the low-lying baryon 56 or meson 36 supermultiplets are shown to follow from general model-independent algebraic properties. All models in which transition operators change the state of only a single quark allow only two partial waves for the decay pion and give $SU(6)_w$ relations between decays in each partial wave, while not necessarily relating different partial waves. (auth)

13949 UNIVERSAL SLOPE AND THE NONLINEAR REGGE TRAJECTORIES. Crewther, D.; Joshi, G.C. (School of Physics, University of Melbourne, Parkville, Victoria, Australia 3052). Phys. Rev. D 9: No. 5, 1446-1449 (1 Mar 1974).

We have investigated constraints imposed by duality on the slopes of nonlinear trajectories. In Argand-loop analysis for square-root-type trajectories we show analytically that the leading and daughter trajectories in the s channel have the same form, except for an additive constant, as the input trajectory in the t channel. This result is also true for all leading nonlinear trajectories in a model proposal by Cohen-Tannoudji, Henyey, Kane, and Zakrzewski. (auth)

13950 IMPLICATIONS OF PARTON-MODEL CONCEPTS FOR LARGE-TRANSVERSE-MOMENTUM PRODUCTION OF HADRONS. Ellis, S.D. (National Accelerator Laboratory, P. O. Box 500, Batavia, Illinois 60510); Kislinger, M.B. Phys. Rev. D 9: No. 7, 2027-2051 (1 Apr 1974).

We study the implications of the parton-parton scattering picture for large-transverse-momentum hadronic events. Topics discussed are single and double inclusive cross sections, two-jet cross sections, multiplicities, quantum numbers, and contributions to σ_{tot} and $d\sigma/dt|_{t=0}$. (auth)

13951 MULTIPERIPHERAL AND DIFFRACTIVE COMPONENTS OF THE TOTAL CROSS SECTION IN GRIBOV'S REGGEON CALCULUS. Sukhatme, U.P.; Pajares, C. (Department of Physics, University of Washington, Seattle, Washington 98195). Phys. Rev. D 9: No. 7, 2119-2124 (1 Apr 1974).

The usual classification of multiparticle processes into those with no large rapidity gaps (multiperipheral) and those with at least one large gap (diffractive) is made in the framework of Gribov's Reggeon calculus. (A rapidity gap is defined to be large if it exceeds a fixed, critical gap size ξ_c). General formulas for the multiperipheral and diffractive contributions to the total cross section are obtained by cutting the leading Reggeon diagrams in the elastic amplitude and analyzing the intermediate states. The cutting procedure is always applied to physical Pomeranchukons. In obtaining our results, we assume that when a physical Pomeranchukon with rapidity span ξ is cut, the probability $p(\xi)$ of having a multiparticle intermediate state with no large rapidity gaps is given by $p(\xi) = e^{-\gamma\xi}$, $\gamma > 0$. This form is shown to be reasonable if long-range correlation effects are not important. Our results depend on the new parameter γ, which is of course a function of the critical gap size ξ_c. At CERN ISR energies, the Pomeranchukon-cut contributions are found to be very important, and must be included along with the pole contribution. (auth)

13952 CHARGE CONSERVATION AND REGGE COUPLINGS IN INCLUSIVE REACTIONS. Amann, R.F.; Blackmon, M.L.; Geer, K.A. (Physics Department, Syracuse University, Syracuse, New York 13210). Phys. Rev. D 9: No. 5, 1508-1514 (1 Mar 1974).

Using charge-conservation constraints for inclusive reactions, we derive sum rules which relate double-Regge couplings to each other and to differences of Regge trajectories. These sum rules constitute a set of coupled nonlinear equations and are sufficiently restrictive to be used as a bootstrap to determine all double-Regge couplings, once the number and type of trajectories are specified. The sum rules for the double-Pomeron coupling are utilized as a basis for specific experimental predictions. (auth)

13953 PARTICLE RATIOS IN ENERGETIC HADRON COLLISIONS. Bjorken, J.D. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305); Farrar, G.R. Phys. Rev. D 9: No. 5, 1449-1453 (1 Mar 1974).

We construct a simple statistical model in order to estimate, for very energetic collisions, the ratios of particles with various quantum numbers produced with center-of-mass momenta less than a few GeV. Two conclusions are that (1) isobar decay can account for a large fraction of the SU(3) violation observed experimentally, and (2) at high transverse momentum the dominance of pions diminishes. (auth)

13954 NUCLEAR PHYSICS AND HIGH ENERGY PHYSICS. Section B. Particle Physics. Conference held at Hamburg, Germany, February 20–22, 1974. Abstracts of Papers. Weinheim, Ger.; Physik Verlag GmbH (1974). 24p. (In German and English). (CONF-740225–(Absts.)).

From conference on nuclear physics and high energy physics; Hamburg, F. R. Germany (20 Feb 1974).

Here are 51 abstracts of papers on strong interactions, electromagnetic interactions, and weak interactions compiled. Also 18 additional abstracts which were received late are included. (JSR)

13955 SELF-CONSISTENT MODEL FOR DIFFRACTIVE SCATTERING. Davidson, M. (Physics Department, University of Illinois at Urbana-Champaign, Urbana, Illinois 61801). Phys. Rev. D 9: No. 3, 786-797 (1 Feb 1974).

Crossed-channel unitarity is imposed on a Regge eikonal model. An integral equation is thereby found for the elastic π-π scattering amplitude. The simplest solution is the formation of a fixed singularity at $J = 1$, which yields behavior identical to the droplet model of Chou, Wu, and Yang. Integral equations for the residue function of the fixed pole are presented. The possibility of other solutions is discussed. (auth)

13956 POMERON CUTS AND INCLUSIVE REACTIONS. Creutz, M.; Paige, F.E.; Shen, P. (Brookhaven National Laboratory, Upton, New York 11973). Phys. Rev. D 9: No. 3, 684-696 (1 Feb 1974).

The contributions of Pomeron cut to inclusive cross sections in the central region are studied within the framework of the Reggeon calculus. The two-particle correlation function contains a term independent of the rapidities of the observed particles and only weakly dependent on the total rapidity Y. The integrated correlation functions f_n grow as Y^{n-1} and satisfy Le Bellac's inequality automatically. The multiplicity distribution contains multiple peaks at very high energy. (auth)

13957 PART I. SOME ASPECTS OF LOCAL DUALITY. PART II. THE PHENOMENOLOGY OF THE MULTI-PERIPHERAL MODEL. Shah, P. M. New York; Syracuse Univ. (1973). 140p. University Microfilms Order No. 74-10,175.

Thesis (Ph. D.).

Two different aspects of strong interaction dynamics are investigated. First, a model is considered in which a set of particles degenerate in mass but differing in spins, parities, and belonging to different SU(3) multiplets was required to satisfy local duality in reactions whose crossed channels are exotic. Local duality conditions imply relations between coupling constants for sets of particles degenerate in mass but differing in spins, parities, and SU(3) assignments. The coupling constants of the solution in the exact SU(3) limit were used and the partial widths of the resonances for decays into the $\bar{K}N$ channel were calculated. Broken SU(3) symmetry is incorporated by using physical masses to calculate phase-space and barrier factors. Cross sections coming from the contributions of the resonances alone were computed for the reaction $K^-p \to K^-p$ and $K^-p \to \bar{K}^0n$ for the center-of-mass energy range 1.720 to 1.930 GeV. There is good over-all agreement with experimental results including the peaks in the backward differential cross sections for both reactions. The model was extended to study the consequences of local duality in the reactions $K^-p \to \pi^+\Sigma^-(1385)$ and $\pi^+p \to \pi^+\Delta^{++}(1236)$. To test the predictions of local duality, within the framework of the general considerations of angular momentum and parity conservation the structure of the spin-$\frac{1}{2}$ polarization density matrix of a particle which is produced in a reaction in which a single resonance of definite spin and parity dominates the production mechanism is studied. The results can be generalized to a slightly more complicated model in which the exchange of several resonances dominates the production mechanism. Secondly, the customary assumption of the neglect of interference terms between Feynman diagrams in which a given set of final particle states (quantum numbers and momenta) is emitted in different orders along the multiperipheral chain within a simple multiperipheral model is investigated. The inclusion of these interference terms in a multi-Regge model allows the correct prediction of the ratio of Kp to πp cross sections and of the energy dependences of the inelastic cross sections and pion multiplicity. Furthermore the inclusion of these interference terms in a multi-Regge model gives excellent agreement with the measured two-particle correlation function. The sum rules for baryon number and hypercharge annihilation cross sections, both total and inclusive, are examined in the numerically developed multiperipheral model with the explicit inclusion of these interference terms. These sum rules allow Feynman scaling and the Mueller-Regge analysis to the annihilation channel. A multiperipheral model, based in part on these sum rules, provides an excellent description of the gross features of the existing annihilation data. (Diss. Abstr. Int., B)

13958 POLARIZATION PHENOMENA AND COMPOSITE STRUCTURE OF HADRONS. Takada, Y. (Tokyo Ins. Of Tech.). Progr. Theor. Phys. (Kyoto); 50: No. 6, 1928–1944 (Dec 1973).

Theoretical investigations of polarization phenomena of high energy hadron–hadron scattering are carried out in a composite model of hadrons. A Franco–Glauber type spin dependent multiple scattering formulation is used, which is rederived by the use of an eikonal approximation method. It is shown that the double spin flip terms inevitably lead to ρ'-trajectory with parameters $\alpha_{\rho'}(0) = \alpha_\rho(0) - \frac{1}{2}$, $\alpha'_{\rho'}(0) = \alpha'_\rho(0)$ for π^-p charge exchange scattering. (auth)

13959 REPRESENTATIVE INTERACTIONS IN MULTIPARTICLE PRODUCTIONS. Kagiyama, S. (Fukuoka Univ.); Kinoshita, K. Progr. Theor. Phys. (Kyoto); 50: No. 6, 1965–1972 (Dec 1973).

From research meeting on high energy multiparticle productions; Kyoto, Japan (24 May 1973).

A model for multiparticle production is investigated which contains three kinds of representative trajectories, corresponding to the propagators in the multiperipheral form of the urbaryon rearrangement diagrams. (auth)

13960 LIFETIME EFFECTS IN COUPLED CHANNEL PROBLEMS. Kamal, A. N.; Kreuzer, H. J. (Univ. of Alberta, Edmonton). Can. J. Phys.; 52: No. 7, 608–617 (1 Apr 1974).

Lifetime effects of unstable particles in coupled channel problems are studied in a simple field theoretical model and in some nonrelativistic 2-channel models. The instability of higher channel particles is taken into account via self-energy effects. Resonance and cusp modifications are studied numerically in great detail. (auth)

13961 HOW TO CALCULATE LOW-ENERGY PARTIAL-WAVE PARAMETERS OF DUAL RESONANCE AMPLITUDES. Chung, B.K.; Feldman, D. (Department of Physics, Brown University, Providence, Rhode Island 02912). Phys. Rev. D 9: No. 6, 1845-1847 (15 Mar 1974).

It is shown that the low-energy parameters for all classes of dual, elastic scattering amplitudes can be readily derived by simple use of Rodrigues's formula for the Legendre polynomials. (auth)

13962 MULTI-REGGE LIMIT OF THE NEVEU-SCHWARZ MODEL. Moen, I.O. (Physics Department, McGill University, Montreal, Canada); Montonen, C.; Zakrzewski, W.J. Phys. Rev. D 9. No. 6, 1717-1722 (15 Mar 1974).

The structure of the Neveu–Schwartz model in multi-Regge limits is studied, with particular emphasis on quantum-number effects on Reggeon-particle vertex functions. (auth)

13963 HOW TO TEST SCALING IN ASYMPTOTICALLY FREE THEORIES. Gross, D.J. (Rockefeller University, New York, New York 10021). Phys. Rev. Lett. 32: No. 19, 1071-1073 (13 May 1974).

It is shown how, in asymptotically free gauge theories, one can, given the deep-inelastic structure functions for values of q^2 in the asymptotic region, calculate explicitly the structure functions for all larger q^2. The ratio of structure functions for $q^2 = 50$ and 5 GeV^2 is estimated. Substantial deviations from scaling are found, as well as a dramatic ω dependence, for values of $1 \leq \omega \leq 4$. (auth)

13964 RISING CROSS SECTIONS AND SCALING. Caprasse, H.; Burnel, A. (Service de Physique Théorique et Mathématique, Université de Liège, Liège 1, Belgium). Phys. Rev. D 9: No. 7, 1980-1990 (1 Apr 1974).

A parametrization for total cross sections, which incorporates a logarithmically rising term, is proposed. The new parameters present in it are restricted, using a scaling assumption for q^2 in the timelike region. The resulting expression contains only one parameter in addition

to the usual Regge parameters. In the energy range between 10 and 400 GeV/c this model gives very good fits for π^+p, K^+p, pp, and $\bar{p}p$ total cross sections. Above 400 GeV/c, the agreement with recent data on the pp total cross section is only qualitative. The model also predicts the vanishing of the ratio of real to imaginary parts of the pp forward elastic amplitude at 360 GeV/c in agreement with experimental data, the increase of this ratio to a maximum value, and a vanishing asymptotic limit. (auth)

13965 DYNAMICAL AND SYMMETRY EFFECTS IN THE K/π RATIO IN THE CENTRAL PLATEAU. Barnett, R.M.; Silverman, D. (Department of Physics, University of California, Irvine Irvine, California 92664); Scadron, M.D.; Thews, R.L. Phys. Rev. D 9: No. 7, 2195-2197 (1 Apr 1974).

Produced-mass and internal-mass effects are used along with symmetry considerations in a general peripheral structure to account for the K/π ratio in the central plateau with no free parameters. The increase of the ratio with increasing $q_\perp$ is accounted for. (auth)

13966 MODELS OF ELECTROMAGNETIC AND STRONG INTERACTIONS OF HADRONS. Snell, V. G. Toronto; Univ. of Toronto (1972). National Library of Canada, Ottawa.

Thesis (Ph. D.).

The electromagnetic interactions of hadrons are investigated. The formalism for the elastic scattering of photons from hadrons is described for the case where the target hadron is pointlike in structure, and for the case where it is extended. Ideas which are used to describe the electromagnetic interactions of hadrons are briefly discussed, i.e., quantum electrodynamics, current algebra, and analyticity in energy. The experimental data on these interactions (for nucleons and pions) is presented, and models used to describe it are discussed. A high energy model for nucleon and pion Compton scattering having Regge behavior, crossing symmetry, and a nonzero scale-invariance limit is then constructed. Good fits are obtained with this model to the total photon–nucleon cross section, to the differential cross section for proton Compton scattering, and to the structure functions for inelastic electroproduction in the nonresonant region; for pions, the total cross section in the annihilation region, for production of a pion plus any hadrons, is calculated and found to agree with the preliminary data. The consequences of analyticity in the energy variable are examined. Sum rules are constructed which require terms in the high energy expansion of the scattering amplitude other than Regge poles, although the latter remain as a good approximation to the data. It is found that cuts in the angular momentum plane are good candidates for such terms. The connection between the high-momentum-transfer-fall-off of the nucleon (and pion) electromagnetic form factors and the rate of approach to scale invariance is pointed out. Mentioned briefly are the results of application of a model for strong interactions to $\pi\pi$ and $K\pi$ scattering. (Diss. Abstr. Int., B)

13967 GALILEAN SUBDYNAMICS AND THE DUAL RESONANCE MODEL. Biedenharn, L.C. (Physics Department, Duke University, Durham, North Carolina 27706); van Dam, H. Phys. Rev. D 9: No. 2, 471-486 (15 Jan 1974).

Dynamics in Minkowski space is discussed in terms of an eight-parameter extended Galilei group, a subgroup of the Poincaré group. This method—Galilean subdynamics—is developed and discussed in detail and applied to the construction of two explicit models having four-point amplitudes of the Veneziano type. There are no difficulties with unphysical states. (auth)

13968 ARE BOOTSTRAPS OF LOW-SPIN PARTICLES MEANINGFUL?. Grisaru, M.T.; Tsao, H. (Department of Physics, Brandeis University, Waltham, Massachusetts 02154). Phys. Rev. D 9: No. 2, 512-514 (15 Jan 1974).

We argue that for spin-1/2 and spin-1 particles bootstraps may be trivial. In many instances such particles can be embedded in a renormalizable Lagrangian formalism in which they may Reggeize. In such instances a correctly carried out calculation will produce bootstraps for any values of mass and coupling constant. (auth)

13969 RELATIVISTIC PARTON INTERPRETATION OF THE NEVEU-SCHWATZ MODEL. Willemsen, J.F. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). Phys. Rev. D 9: No. 2, 507-511 (15 Jan 1974).

The Lorentz generators for the Neveu-Schwarz theory, recently obtained by Iwasaki and Kikkawa from a zweiben formalism, are here derived with an emphasis on the parton interpretation of the results. This derivation may shed new light on possible ways to construct new dual models. (auth)

13970 HADRONS AND SU(3): A CRITICAL REVIEW. Samios, N.P. (Brookhaven National Laboratory, Upton, New York 11973); M. Goldberg, Meadows, B.T. Rev. Mod. Phys. 46: No. 1, 49-81 (Jan 1974).

The spectroscopy of hadrons, both bosons and baryons, is critically examined with respect to the SU(3) classification scheme. This is done with respect to the Gell-Mann/Okubo mass formula and the partial decay rates of member states of individual SU(3) multiplet families. The agreement is exceedingly good. The baryons are catalogued into octets with $J^P=1/2^+$, $5/2^+$, and $5/2^-$, nonets with $J^P=3/2^-$, $7/2^-$, and $1/2^-$, and decimets with $J^P=3/2^+$ and $7/2^+$. Among the bosons, nonet structure is well established for J^{PC} multiplets $= 0^{-+}$, 1^{--}, and 2^{++}, with less firm evidence existing for a host of other multiplets, $J^{PC}=0^{++}$, 1^{+-}, 1^{-+}, 2^{--}, 2^{-+}, and 3^{--}. (auth)

13971 FIXED-ANGLE BEHAVIOR IN 4-POINT DUAL MODELS. I. ABSOLUTELY CONVERGENT SERIES OF BETA FUNCTIONS. Gardiner, C.W. (School of Science, University of Waikato, Hamilton, New Zealand and Physics Department, Syracuse University, Syracuse, New York 13210). Phys. Rev. D 9: No. 8, 2340-2348 (15 Apr 1974).

The large-s fixed-angle asymptotic behavior of scattering amplitudes of the form $T(s,t,u) = A(s,t)+A(s,u)+A(u,t)$, with $A(s,t) = \Sigma^\infty_{n=0}C_nB(H-\alpha(s),h-\alpha(t))$, is studied. We find that the asymptotic behavior is determined by the function $F(z) = \Sigma^\infty_{n=0}C_nz^n$. If F(z) is entire the Veneziano fixed-angle behavior is preserved. If F(z) is singular at $z=\lambda$, λ real and larger than one, a different, but still exponentially damped, fixed-angle behavior is produced around the forward and backward regions. If $\lambda=1$, we find a behavior which depends critically on the growth of Im(S) as $Re(S)\to\infty$ [$S\equiv\alpha(s)$]. We find, in particular, that the models of Mandelstam and Frampton have this last type of fixed-angle behavior. The same is true of the model of Gervais and Neveu, unless their choice $a_0=-1$ is made. The model of Neveu and Schwarz, however, does have the usual Veneziano fixed-angle behavior. We finally relate our work to that of Ellis and Freund, and find some discrepancy, which we comment on. (auth)

13972 CLASSICAL DIRECT INTERSTRING ACTION. Kalb, M.; Ramond, P. (Physics Department, Yale University, New Haven, Connecticut 06520). Phys. Rev. D 9: No. 8, 2273-2284 (15 Apr 1974).

We generalize the classical action-at-a-distance theory between point particles to include one-dimensionally extended objects (strings) in space-time. We build parameterization-invariant couplings which lead to equations of motion for strings in each others' influence. The direct coupling of the area elements of the world sheets of the strings is considered in detail, from which we define an antisymmetric adjunct field. We find that, for a given interaction, the nature of the forces depends on the type of strings involved, that is, open- vs close-ended. Our coupling can be understood in terms of states appearing in the Veneziano and Shapiro-Virasoro models in 26 dimensions. However, we find an additional massive pseudovector field which arises from the interaction between the "Reggeon" and "Pomeron" sectors of this dual model. (auth)

13973 UNITARY MULTIPERIPHERAL MODEL WITH ISOSPIN. Sugar, R.L. (Department of Physics, University of California, Santa Barbara, California 93106). Phys. Rev. D 9: No. 8, 2474-2477 (15 Apr 1974).

A unitary, multiperipheral model is contructed in which isospin is taken into account. Unlike previous models of this type in which internal quantum numbers were neglected, it is possible to arrange both for saturation of forces between the multiperipheral chains and for a Pomeranchuk pole with intercept one. (auth)

13974 PHYSICAL TRAJECTORIES IN AN INCLUSIVE DUAL RESONANCE MODEL. Randa, J. (Physics Deparment, University of Illinois at Urbana-Champaign, Urbana, Illinois 61801). Phys. Rev. D 9: No. 9, 2612-2626 (1 May 1974).

Previous work on the dual resonance model in inclusive vector-meson production is extended to include both abnormally coupled trajectories and trajectories with positive intercept. Differential cross sections and density-matrix elements are obtained and compared to those of the previous calculation. The single-particle spectrum for spinless mesons is also obtained and compared to earlier results. (auth)

13975 SINGLE-CLUSTER FORMATION IN THE STATISTICAL BOOTSTRAP MODEL. Hamer, C.J. (Brookhaven National Laboratory, Upton, New York 11973). Phys. Rev. D 9: No. 9, 2512-2528 (1 May 1974).

Single-cluster formation in hadronic reactions is discussed, within the context of the statistical bootstrap model. This process is analogous to compound nucleus scattering in nuclear physics, and similar formulas hold for the formation cross section. If the average resonance width should rise indefinitely with energy, the model will eventually run into conflict with unitarity; the trouble is traced to a breakdown of the "narrow-resonance approximation." The effects of angular momentum conservation on the cluster decay are considered, and formulas are presented for the multiplicity and single-particle momentum distribution as a function of the cluster's spin. Brief discussions are given of possible experimental tests of the model, including the annihilation reactions e^+e^-–hadrons and NN–mesons, which are particularly favorable cases. In an appendix it is shown how to estimate asymptotic parameters in a "realistic" model by analytic means. (auth)

13976 COMPATIBILITY OF HYDRODYNAMIC EQUATIONS WITH THE GENERALIZED MULTIPERIPHERAL PICTURE. Thomas, G.H. (High Energy Physics Division, Argonne National Laboratory, Argonne, Illinois 60439). Phys. Rev. Lett. 32: No. 21, 1210-1212 (27 May 1974).

A way of resolving the difference between the Fermi–Landau and multiperipheral pictures of particle production is suggested. The basic observation is that if the Fermi–Landau fluid is already one-dimensional in the formation stage, then the entropy will be greatly reduced compared to the standard treatment. This allows the possibility for logarithmic growth with energy of the multiplicity, in agreement with the multiperipheral picture. (auth)

13977 ROLE OF THE POMERON IN TENSOR–MESON DOMINANCE. Mohan, L.R.R. (Department of Physics, Purdue University, Lafayette, Indiana 47907); Vasavada, K.V. Phys. Rev. D 9: No. 9, 2627-2630 (1 May 1974).

We include the Pomeron contribution in the tensor–meson dominance relations and find that (i) the previous discrepancies are resolved, (ii) the mass radii satisfy the Gell–Mann–Okubo type relations, and (iii) some bounds on the Pomeron slope and the tensor F/D ratio, consistent with experiments, are obtained. (auth)

13978 CHANNEL LIKELIHOOD: AN EXTENSION OF MAXIMUM LIKELIHOOD FOR MULTIBODY FINAL STATES. Condon, P.E.; Cowell, P.L. (University of California at Irvine, Irvine, California 92664). Phys. Rev. D 9: No. 9, 2558-2562 (1 May 1974).

We present here an extension of the maximum–likelihood method. We demonstrate that the estimation of certain parameters, which are important in the analysis of multibody final states in nuclear interactions, is equivalent in power to that of maximum likelihood. We indicate how this new method gives valuable guidance in improving the nature of the hypothesis under test, and how the method can be interpreted as a technique for separating a body of experimental data into a number of resonant channels on an event–by–event basis. (auth)

13979 SHIELDING OF THE POMERON. Oehme, R. (The Enrico Fermi Institute and the Department of Physics, University of Chicago, Chicago, Illinois 60637). Phys. Rev. D 9: No. 9, 2695-2697 (1 May 1974).

A Pomeron trajectory describing rising cross sections is generally a hard branch–point unitarity in the t channel. These shielding singularities may well be important phenomenologically. (auth)

13980 BREMSSTRAHLUNG MODEL OF DIFFRACTIVE PRODUCTION. Fried, H.M. (Department of Physics, Brown University, Providence, Rhode Island 02912); Kirby, B.J. Phys. Rev. D 9: No. 9, 2691-2693 (1 May 1974).

Diffractive bremsstrahlung production is superimposed upon a tower–graph Pomeron eikonal to generate an explicit realization of Blankenbecler's theorem and of that special situation which can occur when diffractive and nondiffractive processes cannot be separated, while providing a model which can fit an increasing σ to over a finite energy range. (auth)

Strong (Baryon No. = 0)

Refer also to abstract 14059.

13981 (COO-3227-38) BEYOND THE RISING TOTAL CROSS SECTIONS. Wu, T. T.; Cheng, H. (Harvard Univ., Cambridge, Mass. (USA). Gordon McKay Lab.; Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Mathematics). 1973. Contract AT(11-1)-3227. 40p. (CONF-730841-4). Dep. NTIS $5.00.

From fifth international conference on high energy collisions; Stony Brook, New York, USA (23 Aug 1973).

The theoretical reasoning that leads to the prediction of, among others, total cross section rising like $(\ln s)^2$ is reviewed. Briefly, relativistic kinematics dictate the dependence on longitudinal momentum of particles produced in the pionization region, and lead to a factor of ln s in the integrated cross section. Unitarity in the t-channel then amplifies this ln s to be a power of s, divided possibly by a power of ln s. This power of s is a realization of the strongly absorptive potential with a coupling constant increasing with energy, and thus the Froissart bound for total cross sections is saturated. Many other results, concerning in particular the phases of the scattering amplitudes in the forward direction and differential cross sections for both elastic and inelastic diffractive scattering, are obtained at the same time. In order to make quantitative comparison with experimental data, past and future, a simple model of hadron scattering is described. When applied to the elastic scattering of pp, $\bar{p}p$, $\pi^{\pm}p$, and $K^{\pm}p$, this model describes reasonably well existing data beyond 20 GeV. From the resulting parameters, quantitative predictions about these processes are given in detail up to the highest energy that may become available from accelerators in this century, namely 1.5 on 1.5 TeV. The considerations are also extended to inelastic diffractive scattering without spin-parity exchange. A number of problems related to increasing total cross sections, some unsolved, are discussed. (auth)

13982 (NP-20029) PION FORM FACTOR FROM INELASTIC $\pi\pi$ SCATTERING. Roos, M. (Helsinki Univ. (Finland). Dept. of Nuclear Physics). 10 Dec 1973. 39p. Dep. NTIS (US Sales Only) $5.00.

Attempts are made to account for $\eta(s)$, the elasticity of the I = J = 1 partial wave $\pi\pi$-scattering amplitude, in formulations of the pion form factor $F_\pi(s)$. Taking $\eta(s)$ and the phase shift $\delta(s)$ from phase shift analyses of virtual $\pi\pi$-scattering, $|F_\pi(s)|^2$ is computed in the time-like region. For the pion r.m.s charge radius the quantity $r_\pi = 0.7$ is found. Comparison with the directly measured $|F_\pi(s)|^2$ values in the reaction $e^+e^- \to \pi^+\pi^-$, permits one to draw some conclusions about the zeros of the form factor. (auth)

13983 (RL-74-63) IS THE O^+ NONET RESPECTABLE. Morgan, D. (Science Research Council, Chilton (UK). Rutherford High Energy Lab.). Apr 1974. 23p. Dep. NTIS (US Sales Only) $4.25.

A scheme of assignments for the O^+ nonet is proposed with the S^* (1000) effect corresponding to resonance poles both on sheet II and sheet III, and with the ϵ located somewhere above 1100 MeV, e.g. at 1300 MeV. A tentative fit of the decay characteristics of these and the other nonet candidates, $\delta(970)$ and $\kappa(\sim 1200)$ is achieved with the mixing angle given by $\cos^2\theta_S \sim 0.13$ instead of the "ideal" value of $\frac{1}{3}$. (auth)

13984 (RL-74-68) WHAT A DOMINATING RHO AND WEAK EXOTICS CAN DO FOR $\pi\pi$ SCATTERING NEAR THRESHOLD. Pennington, M. R. (Science Research Council, Chilton (UK). Rutherford High Energy Lab.). May 1974. 28p. Dep. NTIS (US Sales Only) $4.50.

It is shown in $\pi\pi$ scattering, that ρ-dominance of the I = 1 absorptive part, together with the weakness of exotic channels, makes it possible to deduce, without any detailed knowledge of the I = 0 $\pi\pi$ amplitude phenomenologically well satisfied relation between threshold parameters. In particular, the "universal curve" of Morgan and Shaw (Phys. Rev.; D2: 520(1970)) and quasilinearity of subthreshold s-wave amplitudes are reproduced and the sizes of p- and d-wave amplitudes are determined. (auth)

13985 ANALYSIS OF $\bar{P}P$ INTERACTIONS AND THE QUARK–PARTON MODEL. Bussian, A.E. (Randall Laboratory of Physics, University of Michigan, Ann Arbor, Michigan 48104). Phys. Rev. D 9: No. 5, 1384-1388 (1 Mar 1974).

An analysis of $\bar{p}p$ interactions is made assuming that hadrons are composed of totally absorbing subparticles. If quarks are assumed to be the basic constituents, their mass and radius are in reasonable agreement with the Drell–Johnson model. If the subparticles are assumed to be Schwarzschild spheres, the resulting mass and radius agree with Planck's characteristic mass and length, respectively. Furthermore, the resulting mass density of partons is of the correct order of magnitude to be gravitationally bound into nucleons. (auth)

13986 $\eta \to 3\pi$ IN A RENORMALIZABLE SU(3) σ MODEL. Hudnall, W.; Schechter, J. (Physics Department, Syracuse University, Syracuse, New York 13210). Phys. Rev. D 9: No. 7, 2111-2118 (1 Apr 1974).

The problem of predicting the $\eta \to 3\pi$ decay rate in terms of the K^+–K^0 mass difference is discussed in the framework of a renormalizable SU(3) σ model. Order–of–magnitude agreement for the process is finally achieved. In addition, some connections with unified weak–electromagnetic gauge schemes are explored. (auth)

13987 RADIATIVE CORRECTIONS IN ELASTIC HADRON SCATTERING. Sogard, M.R. (Physics Department and Laboratory for Nuclear Science, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). Phys. Rev. D 9: No. 5, 1486-1498 (1 Mar 1974).

The radiative correction to elastic hadron scattering is derived and evaluated for a number of processes including scattering from nuclei. The size of the correction is in some instances substantial, and some experimental results, as well as conclusions drawn from them, should probably be reevaluated. (auth)

13988 DUAL ANALYSIS OF THE PROCESS $\bar{P}N \to 3\pi$ AT REST AND IN FLIGHT. Nicholas, L.E. (Department of Mathematics, Heriot–Watt University, Edinburgh, Scotland). Phys. Rev. D 9: No. 5, 1330-1334 (1 Mar 1974).

A comparison of Veneziono 5–point–function fits to the $\bar{p}n \to 3\pi$ at–rest Dalitz–plot data is made using the maximum–likelihood method.

A sum of 4-point functions is similarly fitted to the in-flight data at 1.2 GeV/c. (auth)

13989 PERIPHERALITY AND EXCHANGE MECHANISMS OF FOUR-BODY FINAL STATES INDUCED BY π^+p AND $\bar{p}p$ INTERACTIONS. Bastien, D.; Haber, B.; Hodous, M.F.; Hulsizer, R.I.; Kistiakowsky, V.; Pless, I.A.; Singer, R.A.; Wolfson, J.; Yamamoto, R.K. (Massachusetts Institute of Technology, Cambridge, Massachusetts 02139); Bastien, P.; Kirkpatrick, L.; Lubatti, H.J. Phys. Rev. D 9: No. 5, 1393-1403 (1 Mar 1974).

We define a kinematical variable P_ν which is correlated to the peripherality of a multibody final state. $P_\nu=0$ implies that all the final state particles lie in a plane perpendicular to the incident direction. $P_\nu=1$ implies that all the particles in the final state are collinear with the incident direction. P_ν distributions for resonance production are quite different from those for Lorentz-invariant phase space. This property may be used to detect phase-space-like phenomena at high energies in multibody final states ($n \geq 10$). We compare P_ν distributions for the four-body annihilation and nonannihilation channels of $\bar{p}p$ interactions and the four-body final states of π^+p interactions in which the proton goes into the backward and forward hemispheres. We find remarkable kinematic similarities between annihilation and π^+p backward-hemisphere channels. We suggest that this is due to the dominance of baryon exchange. There is also a remarkable, but different, similarity between nonannihilation and the π^+p forward-hemisphere channels. We suggest that this is due to the dominance of meson exchange. (auth)

13990 TRANSVERSE-MOMENTUM DISTRIBUTION OF INCLUSIVE PIONS. Pinsky, S.S.; Stevens, P.R. (Department of Physics, University of California, Riverside, California 92502). Phys. Rev. D 9: No. 3, 833-835 (1 Feb 1974).

We study the transverse-momentum distribution of pions that come from the decay of ρ's. We find that the inclusive transverse-momentum distribution of such pions will exhibit a turning over as $k_\perp^2 \to 0$. This effect is strictly kinematic and will appear in any model where π's come from the decay of unpolarized low-mass clusters which have a $p_\perp^2$ distribution that is peaked at $p_\perp^2 = 0$. (auth)

13991 FIXED POLES AND COMPOSITENESS. Hite, G.E. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87544); Müller-Kirsten, H.J.W. Phys. Rev. D 9: No. 4, 1074-1084 (15 Feb 1974).

A field-theoretic model of πV scattering is constructed in order to obtain and compare the high-energy behavior of helicity amplitudes for the processes $\pi\gamma \to \pi\gamma$, $\pi\gamma \to \pi p$, $\pi p \to \pi p$ and hence to arrive at conclusions with regard to the occurrence of fixed J-plane poles. The model is based on the Wick-Cutkosky scalar theory, in which the dynamics is due to exchange of massless scalar mesons. Full use is made of the fact that the integral equations of the three-point and four-point functions of this theory may be solved explicitly in the ladder approximation. The solutions of the inhomogeneous equations are investigated in detail—in particular their asymptotic behavior when one of the particles is far off the mass shell. They are then inserted into our model diagrams and the asymptotic behavior of amplitudes of the processes mentioned above is derived on the assumption that the ρ meson is a composite state which lies on a Regge trajectory, whereas the photon is not. This definition of compositeness is seen to be equivalent to the condition of vanishing of the appropriate vertex renormalization constant. The occurrence of significant fixed-pole contributions in Compton scattering is reaffirmed. Finally some remarks are made with regard to the vector-meson-dominance hypothesis. (auth)

13992 NONLINEAR BOOTSTRAP FOR MESONS IN A DUAL MODEL. Maharana, J. (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 50: No. 5, 1626-1643(Nov 1973).

A nonlinear equation for the Veneziano residue functions is obtained in a dual resonance model. The unitarity property of the dual amplitudes in the narrow resonance limit and the Tye-Veneziano duality for inclusive reactions are used to obtain self-consistency conditions on the residue functions. The coupling constants thus obtained are used to compute various decay modes of vector and tensor mesons. Some of the results are in good agreement with the experimental data. (auth)

13993 σ COMMUTATOR, HARD-PION PARAMETERS, AND s-WAVE ππ PHENOMENOLOGY. Brehm, J.J.; Golowich, E. (Department of Physics and Astronomy, University of Massachusetts, Amherst, Massachusetts 01002). Phys. Rev. D 9: No. 7, 2064-2067 (1 Apr 1974).

A description is given of an analysis of the s-wave ππ phase shifts based on analytic hard-pion methods applied to the π-to-π matrix element of the σ commutator. The latter operator is allowed the freedom to have isospin-2 components. The role played by the set of parameters which describes the system is explicated, and the extent to which these parameters can be determined phenomenologically is considered. (auth)

13994 NEGATIVE-KAON MASS. Kunselman, R. (Department of Physics and Astronomy, University of Wyoming, Laramie, Wyoming 82071). Phys. Rev. C 9: No. 6, 2469-2470 (June 1974).

The mass of the negative kaon has been determined to be 493.66 ± 0.19 MeV from measurements of kaonic-atom x-ray energies. The value depends upon considering calculated contributions to the complete atomic cascade. (auth)

13995 MESON DECAYS AND THE DKP EQUATION. Fischbach, E. (Physics Department, Purdue University, Lafayette, Indiana 47907); Nieto, M.M.; Primakoff, H.; Scott, C.K. Phys. Rev. D 9: No. 7, 2183-2186 (1 Apr 1974).

It has been argued that the Duffin-Kemmer-Petiau (DKP) description of mesons fails in predicting meson decay rates and the strong-interactions D/F ratio, while the Klein-Gordon (KG) description succeeds. It is shown here that these arguments are deficient in three respects: (I) The various dynamical assumptions used in comparing the DKP and KG descriptions preclude a rigorous test of their relative merits at present, except in some particularly simple cases: (II) if the same phenomenological freedom were used in the two descriptions the results could be made similar; and (III) actually, when worked out correctly, it is the DKP rather than the KG description which extracts a consistent strong-interaction D/F ratio. (auth)

Strong (Baryon No. = 1)

Refer also to abstracts 14047, 14051, 14178, and 14437.

13996 (JINR-P1-7844) CORRELATIONS OVER THE MULTIPLICITIES OF NEUTRAL AND CHARGED π-MESONS. Angelov, N.; Grishin, V. G.; Kerachev, P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1974. 14p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

Using the experimental data on π^-p interactions at p = 40 GeV/c there were calculated the dispersion and the correlation coefficient, ρ_2^0 for π^0 meson distribution over the multiplicity ($D_0 = 2.94 \pm 0.15$ and $\rho_2^0 = 0.51 \pm 0.15$). Isotopic relations are obtained between the correlation coefficients, ρ_2^i for isotopically nonpolarized system of π- mesons. (auth)

13997 (JINR-P1-7854) TWO-PARTICLE CORRELATIONS IN 40 GeV π^-p INCLUSIVE REACTIONS AND PARTICLE PRODUCTION MECHANISMS. Grishin, V. G.; Sabzy, M.; Solomin, A. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1974. 22p. (In Russian). Dep. NTIS (US Sales Only) $4.25.

Inclusive two-particle correlations in rapidity variables between $\pi^+\pi^+$, $\pi^-\pi^-$ and $\pi^+\pi^-$ pairs obtained in 40 GeV π^-p collisions are discussed in the framework of the Mueller-Regge approach and the multiperipheral cluster model. The data show similar features as the results obtained at much higher energies from the NAL and CERN-ISR. This behavior is more easily understood from the multiperipheral cluster model. Data on transverse momentum correlations in the same reactions can be qualitatively understood from the same model. (auth)

13998 (JINR-P2-7853) DISPERSION RELATIONS FOR THE LOGARITHM OF THE K^+p FORWARD SCATTERING AMPLITUDE. Dumbrais, O. V.; Stashel, M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 16p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

Dispersion relations for the logarithm of the K^+p forward scattering amplitude were evaluated. Contrary to all previous calculations based on conventional dispersion relations the negative sign of the real part of the K^-p scattering amplitude was predicted below ≈1 GeV/c. (auth)

13999 (JINR-P2-7879) POSSIBILITY OF RENORMALIZATION OF MODEL FOR π-N INTERACTIONS WITH PSEUDOVECTOR COUPLING. Malyshkin, V. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 14p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

A model is considered for the π-N interactions with pseudovector coupling. It is shown that the partially summed meson Green function found by the Redmond-Bogolubov-Logunov-Shirkov method leads to the renormalizable model. The meson Green function obtained has correct analytic properties. (auth)

14000 (LBL-3015) BARYON-ANTIBARYON THRESHOLD RESONANCES. Chew, G. F.; Koplik, J. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 6 May 1974. Contract W-7405-eng-48. 15p. (CONF-740713-6). Dep. NTIS $4.00.

From seventeenth international conference on high-energy physics; London, UK (1 Jul 1974).

Experimental and theoretical arguments are presented to support the conjecture of a high density of levels (resonances),

with quantum numbers shared by baryon–antibaryon channels, in the neighborhood of the thresholds for such channels. These levels, generated by long-range pion exchange, are of a nature familiar in classical nuclear physics but usually ignored in particle physics. Their possible relevance to a variety of high energy phenomena is discussed, including the rising tendency of high energy hadronic total cross sections and the anomalously large e^+e^- annihilation. (auth)

14001 NAIVE QUARK-PAIR-CREATION MODEL AND BARYON DECAYS. Le Yaouanc, A.; Oliver, L.; Pène, O.; Raynal, J.-C. (Laboratoire de Physique Théorique et Hautes Energies, Orsay, France). Phys. Rev. D 9: No. 5, 1415-1419 (1 Mar 1974).

It is shown that the naive quark–pair–creation model, perhaps the simplest generalization of the additive quark model treating all the hadrons as composite, correctly describes the observed centrifugal–barrier effect in the baryon decays in which more than one partial wave contributes. Good agreement is found with the partial–wave analysis of Brody et al. of $\pi^- p \to \pi^+ \Delta^-$ in the 1690–MeV mass region. Comparison is made with the previous unsuccessful $SU(6)_W$ predictions and with the work of Petersen and Rosner. (auth)

14002 DECK-MODEL CALCULATION OF $\pi^- p \to \pi^- \pi^+ \pi^- p$. Ascoli, G.; Cutler, R.; Jones, L.M.; Kruse, U.; Roberts, T.; Weinstein, B.; Wyld, H.W. Jr. (Physics Department, University of Illinois at Urbana–Champaign, Urbana, Illinois 61801). Phys. Rev. D 9: No. 7, 1963-1979 (1 Apr 1974).

We formulate and study a Deck–like model for the reaction $\pi p \to \pi\pi^+\pi p$. The model differs from previous Deck calculations in two respects: (I) Experimental data are used for both $\pi\pi$ and πN scattering, and (II) the amplitude has proper Bose symmetry. Feature(I) allows us to examine any desired region of 3π mass (the A_3 is treated on the same footing as the A_1); features (I) and (II) allow us to examine all the angular dependence in the final state and to compare with partial–wave analyses of experimental data. In this paper we present the results of a study in which events generated from the model by a Monte Carlo method are plotted and fitted in the same way as experimental events. Many of the features of the data are qualitatively reproduced, including certain important properties obtained from the partial–wave analysis in the A_1 region. The A_3 region is not accurately represented by the model. Results of an analytic partial–wave analysis of this model, and the use of it to check the assumptions of the fitting program, are presented in an associated paper. (auth)

14003 ABFST-MODEL DESCRIPTION OF $\pi^+ p \to 3\pi^+ 2\pi^- p$ AND RELATED PROCESSES. Dash, J.W. (Argonne National Laboratory, Argonne, Illinois 60439); Huskins, J.; Jones, S.T. Phys. Rev. D 9: No. 5, 1404-1414 (1 Mar 1974).

The ABFST (Amati–Bertocchi–Fubini–Stanghellini–Tonin) model modified by a particurlar off–shell $\pi\pi$–resonance vertex is shown to yield a reasonable description of the reaction $\pi^+ p \to 3\pi^+ 2\pi^- p$ in normalization, energy dependence, and distributions. The off–shell modification is consistent with that required in theoretical calculations of the bare Pomeron at $\hat{\alpha}_0 \sim 0.8$ via the ABFST model. The calculation is consistent with factorization of the ABFST model in describing certain four–prong cross sections by single pion exchange. (auth)

14004 PERIPHERAL PARTIAL WAVES IN K^+p ELASTIC SCATTERING AND THE ACCELERATED-CONVERGENCE-EXPANSION ANALYSIS. Cutkosky, R.E.; Sandusky, J.C. (Carnegie-Mellon University, Pittsburgh, Pennsylvania 15213). Phys. Rev. D: No. 7, 2189-2194 (1 Apr 1974).

Predictions of high partial waves from a recent accelerated–convergence expansion (ACE) partial–wave analysis of K^+P scattering are examined in detail. Comparison with the conflicting results of Alcock and Cottingham and of Fox and Griss reveal agreement with the former and disagreement with the latter. Possible reasons for this discrepancy are discussed. (auth)

14005 ANALYSIS FOR HYPERCHARGE-EXCHANGE REACTIONS IN TERMS OF DISPERSION RELATIONS. Argyres, E.N. (State University College of Arts and Science, Plattsburgh, New York 12901); Contogouris, A.P.; Holden, J.P. Phys. Rev. D 9: No. 5, 1340-1349 (1 Mar 1974).

An analysis of $\pi N \to K\Lambda$ and $\bar{K}N \to \pi\Lambda$ is presented in which the imaginary parts of the amplitudes are in approximate agreement with finite–energy sum rules and the real parts are calculated in terms of the imaginary parts via fixed–t dispersion relations. The resulting differential cross sections and polarizations are in fair agreement with experiment. Certain features and implications of the amplitude structure are discussed. (auth)

14006 DESCRIPTION OF DIFFRACTIVELY PRODUCED MULTIPION ENHANCEMENTS. Margolis, B.; Rudaz, S. (National Accelerator Laboratory, Batavia, Illinois 60510). Phys. Rev. D 9: No. 3, 653-659 (1 Feb 1974).

A model of the diffractive production of multipion states on hydrogen and heavy nuclei is presented. The model is statistical in nature and incorporates the effects due to the competition between many open channels at high mass. In this picture, multipion states are produced in a two–stage process: An excited meson state (fireball) is produced peripherally, through Pomeranchukon exchange, which then proceeds to decay in a manner described by the strong statistical bootstrap. As an application of this model, we study the production of three and five charged pions in pion–induced reactions on hydrogen, deuterium, and heavier nuclei. In particular, the size of the cross section for diffractively producing five charged pions is related uniquely, through factorization, to that for producing three charged pions. The results, including mass distributions, are in good agreement with the available data. (auth)

14007 IMPACT PICTURE AND DIFFRACTIVE DISSOCIATION. Cheng, H. (Department of Mathematics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139); Walker, J.K.; Wu, T.T. Phys. Rev. D 9: No. 3, 749-751 (1 Feb 1974).

Based on the impact picture, we give quantitative predictions on the following three reactions: (i) $p + p \to p + N^*$ (1470), (ii) $\pi + p \to \pi + N^*$ (1470), and (iii) $K + p \to K + N^*$ (1470). Factorization is predicted to be approximately valid except near the dip in reaction (i). (auth)

14008 PARTON MODEL AND THE ADLER SUM RULE. Genova, J. J. Stony Brook, NY; State University of New York (1973). 88p. University Microfilms Order No. 74-6756.

Thesis (Ph. D.).

Aspects of the parton model are discussed. It is formally proved that the parton momentum distributions inside the nucleon are equal to Fourier transforms of nucleon matrix elements of bilocal currents. This demonstrates the equivalence of the parton model and the light cone algebra approaches to deep inelastic lepton nucleon scattering. A discussion is given of an electroproduction sum rule derived by Brandt and Ng. It is shown that they made a physically unreasonable assumption which invalidates their result. The Adler sum rule is considered in the deep inelastic region. Cornwall, Corrigan, and Norton have suggested that the limit of the fixed q^2 sum rule may be nonuniform in the Bjorken limit. This is studied in perturbation theory and using light cone techniques, and the consequences are discussed in terms of the underlying model for the hadrons. (Diss. Abstr. Int., B)

14009 DUAL-RESONANCE MODEL WITH SPIN FOR THE REACTION: $\pi N \to \pi\omega N$. Aurenchle, J. P. P. Urbana, IL; University of Illinois (1973). 150p. University Microfilms Order No. 74-11,937.

Thesis (Ph. D.).

A dual-resonance model with spin is constructed for the reaction $\pi N \to \pi\omega N$ and applied to the data in the region of small momentum transfer between the nucleons. The invariant amplitudes are parameterized as sums of five-point (Bardacki–Ruegg) functions in such a way that the scattering amplitude satisfies the following properties: correct spin-parity structure in all meson channels to leading order; correct Regge limits; correct residues at the lowest poles on all trajectories. The only parameters of the model are coupling constants which are fitted to the quasi two-body reactions: $\pi N \to \rho N$, $\pi N \to \omega N$, $\pi N \to \omega\Delta$ and $\pi N \to BN$. (Diss. Abstr. Int., B)

14010 NUMERICAL EVALUATION OF PARTIAL WAVE CONTRIBUTIONS TO PION–NUCLEON AMPLITUDES. Brunet, R. C. (Univ. of Montreal). Can. J. Phys.; 52: No. 8, 731-742(15 Apr 1974).

Detailed numerical evaluations of the partial wave projections of Feynman diagrams of second- and fourth-order in perturbation for the $\pi N - \pi N$ scattering in the $H = \bar{\Psi}\gamma_5\Psi\varphi$ theory are presented. Perturbative contributions to the S, P, and D waves of isospin $\frac{1}{2}$ and $\frac{3}{2}$ are given in tables of numerical values. Figures regrouping these results show surprising behavior for the ratios $Re^{(4)}/Re^{(2)}$. These tables and figures allow easy calculations with models using low order perturbation terms such as Padé approximants. (auth)

14011 IMAGINARY PARTS OF THE HELICITY AMPLITUDES FOR $K-N(\pi-N)$ SCATTERING. Karasuno, T.; Minami, S.; Terada, M. (Osaka City Univ.). Progr. Theor. Phys. (Kyoto); 50: No. 5, 1615-1625(Nov 1973).

In order to separate the P and P′ exchange amplitudes, the model suggested by Fontan et al. was employed. The helicity amplitudes for elastic $K-N(\pi-N)$ scattering are also studied by making use of the phase shift solutions. The results are compared with those predicted by the dual absorptive model. (auth)

14012 SIMPLE DESCRIPTION OF ANGULAR DISTRIBUTION IN ELASTIC π^+p AND pp COLLISIONS AT HIGH ENERGIES.

Azimov, S. A.; Arushanov, G. G.; Imanbaeva, A. G. (Physical-Technical Inst., Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 2, 64-69(1974). (In Russian).

A previously proposed model is compared with available experimental data on differential cross sections of π^+p and pp scattering. Good agreement with experiment was obtained over a wide interval of energies (2 to 20 GeV) of momentum transfer. (SJR)

14013 HIGH-ENERGY MESON-BARYON SCATTERING IN A QUARK MODEL. Chand, R. (Department of Physics, Himachal Pradesh University, Simla, India). Phys. Rev. D 9: No. 7, 2056-2063 (1 Apr 1974).

In a broken-SU(3) quark model, high-energy scattering processes of the type PN-PB are investigated in the crossed t channel. We assume that the physical baryon octet contained in the direct product $3\otimes3\otimes3$ is given by 8 (physical) $=8\cos\theta+8'\sin\theta$, where the baryon octets 8 and 8' arise from $3\otimes3$ and $3\otimes6$, respectively. It is found that the value $\theta\simeq20°$, which explains reasonably well the available data on (a) high-energy photoproduction of mesons and (b) antiproton-nucleon annihilations into two mesons, also explains reasonably well the recently compiled data on meson-baryon scattering. (auth)

14014 LINEAR ZEROS VERSUS SU(3) IN MESON-BARYON SCATTERING. Mathis, H.B.; Capps, R.H. (Physics Department, Purdue University, West Lafayette, Indiana 47907). Phys. Rev. D 9: No. 9, 2603-2612 (1 May 1974).

Odorico has shown that measurements of certain meson-baryon scattering amplitudes support the postulate that the zeros in the spin-independent amplitudes are approximately linear in the Mandelstam plane. He has shown further that if the postulate is extended to all meson-baryon amplitudes, a violation of SU(3) interaction symmetry is implied. We investigate the possibility of determining from experimental data which of the two principles, the linear-zero postulate or SU(3) interaction symmetry, is better satisfied. The reactions $\bar{K}N\to\pi\Sigma$ and $\pi N\to K\Sigma$ are crucial in this determination. We show that the existing data involving these processes are not in perfect accord with either of the two principles, but favor the linear-zero postulate. (auth)

14015 AN AMATI-BERTOCCHI-FUBINI-STANGHELLINI-TONIN-MODEL DESCRIPTION OF $\pi^-p\to2\pi^-2\pi^+n$. Dash, J. W. (Argonne National Laboratory, Argonne, Illinois 60439); Jones, S. T. Phys. Rev. D 9: No. 9, 2539-2546(1 May 1974).

The Amati-Bertocchi-Fubini-Stanghellini-Tonin model modified by a certain theoretically motivated $\pi\pi$-resonance off-shell behavior is applied to the 5-particle reaction $\pi p\to2\pi^-2\pi^+n$ with no free parameters. The calculation is consistent with factorization of the multiperipheral model and previous phenomenology involving 3-, 4-, and 6-body exclusive data. Reasonable agreement in normalization and distributions is obtained. When this multiperipheral model is supplemented by a simple nonperipheral baryon-exchange model, the agreement is very good. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstract 14176.

14016 (JINR-P2-7870) HYPOTHESIS ON HADRON CLUSTER FORMATION AND THE DATA ON MULTIPLE PRODUCTION IN NUCLEAR MATTER. Kalinkin, B. N.; Shmonin, V. L. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 20p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

It is shown that the hypothesis on the realization of the cluster states in the process of multiple production does not contradict experimental data. (auth)

14017 (N-74-10663) INTERMEDIATE ENERGY PROTON-DEUTERON ELASTIC SCATTERING. Wilson, J. W. (National Aeronautics and Space Administration, Langley Station, Va. (USA). Langley Research Center). Nov 1973. 37p. (NASA-TN-D-7313; L-8915). NTIS $3.00.

A fully symmetrized multiple scattering series is considered for the description of proton-deuteron elastic scattering. An off-shell continuation of the experimentally known two-body amplitudes that retains the exchange symmetries required for the calculation is presented. The one boson exchange terms of the two-body amplitudes are evaluated exactly in this off-shell prescription. The first two terms of the multiple scattering series are calculated explicitly whereas multiple scattering effects are obtained as minimum variance estimates from the 146-MeV data of Postma and Wilson. The multiple scattering corrections indeed consist of low order partial waves as suggested by Sloan based on model studies with separable interactions. The Hamada-Johnston wave function is shown consistent with the data for internucleon distances greater than about 0.84 fm. (STAR) (auth)

14018 (NP-20027) LONG RANGE CORRELATIONS IN THE PIONIZATION COMPONENT. Kajantie, K.; Ruuskanen, P. V. (Helsinki Univ. (Finland). Research Inst. for Theoretical Physics). Mar 1974. 16p. Dep. NTIS (US Sales Only) $4.00.

A simple model for observed pion (in the plateau)-proton (in the fragmentation region) correlations is developed. The model satisfies weak short range order but generates long range correlations by relating the pion multiplicity to the proton elasticity. The magnitude of the normalized pion-proton correlation function is connected to the known properties of mesonic clusters and to the shape of the single-proton spectrum. (auth)

14019 PION EXCHANGE IN THE INCLUSIVE REACTION $p+p\to\Delta^{++}+X$. Gotsman, E. (Department of Physics and Astronomy, Tel-Aviv University, Tel-Aviv, Israel). Phys. Rev. D 9: No. 5, 1575-1578 (1 Mar 1974).

Absorptive pion exchange in the triple Regge model is shown to provide an adequate description for the inclusive production of $\Delta^{++}(1238)$ in proton-proton collisions at an incident energy of 303 GeV. (auth)

14020 K^0 REGENERATION OF DEUTERIUM. Pearson, R. (Stanford Linear Accelerator Center and Department of Physics, Stanford University, Stanford, California 94305). Phys. Rev. D 9: No. 7, 2052-2055 (1 Apr 1974).

A calculation of the process $K^0_1d\to K^0_2d$ is made using the phenomenological fits of Loos and Matthews to the meson-nucleon amplitudes in the Glauber multiple-scattering formalism. The results of a numerical calculation for the scattering cross section are presented for representative values of incident kaon energy for $0\leq-t\lesssim1.4$ GeV^2. (auth)

14021 INCLUSIVE CONTRIBUTIONS TO THE RISING INELASTIC PROTON-PROTON CROSS SECTION. Sivers, D.; von Hippel, F. (High Energy Physics Division, Argonne National Laboratory, Argonne, Illinois 60439). Phys. Rev. D 9: No. 3, 830-833 (1 Feb 1974).

Attention is directed to the nonscaling behavior of inclusive cross sections which may accompany a rising inelastic proton-proton cross section. In particular it is pointed out that the observed "threshold rise" of the invariant inclusive cross section for antibaryon production toward its scaling limit in the CERN ISR energy region sets a mass scale similar to that observed in the rising total cross section. (auth)

14022 EFFECTS OF COULOMB ROTATION ON THE p-p FORWARD SCATTERING AMPLITUDE FROM 0-500 MeV. Arndt, R.A.; Hackman, R.H.; Roper, L.D. (Department of Physics, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061). Phys. Rev. C 9: No. 5, 2050-2051 (May 1974).

A recent phase-shift analysis of p-p scattering from 0-500 MeV has been used to calculate the average Coulomb rotation of the forward nuclear p-p amplitude in this energy range. We find that the rotated amplitude is well represented over this energy range by the unrotated amplitude (the imaginary part of which is related to the total cross section) times a rotation of about 1-2°. This rotation factor should be included in extrapolations of precise p-p differential cross sections through the Coulomb peak. (auth)

14023 BACKWARD N^* PRODUCTION IN PROTON-DEUTERON SCATTERING AND NUCLEAR ISOBAR CONFIGURATIONS. Weber, H.J. (Department of Physics, University of Virginia, Charlottesville, Virginia 22901). Phys. Rev. C 9: No. 5, 1771-1774 (May 1974).

Spectator nucleon isobar production in $pd\to d'N^*$ is studied at 0.5-1.0-GeV proton c.m. energy and proposed as a probe of the (NN^*) content of the deuteron. The N^* spectator distribution from the nucleon pickup mechanism has a maximum at large angles and vanishes at 180°, while the background cross sections of N^*'s produced in the elementary $pN\to NN^*$ collision and N^*'s from a pion-nucleon exchange mechanism peak at 180° and fall off rapidly. For an estimated NN^* (1520) probability of 1.5%, a large-angle cross section of ~0.2 μb/sr is obtained. (auth)

14024 DECK-MODEL CALCULATION OF $\pi^-C\to\pi^+\pi^-\pi^-C_{4,44}{}^*$. Cutler, R.T. (Physics Department, University of Illinois at Urbana-Champaign, Urbana, Illinois 61801). Phys. Rev. D 9: No. 3, 676-683 (1 Feb 1974).

A Reggeized Deck model is used to calculate $\pi^-C\to\pi^+\pi^-\pi^-C_{4,44}{}^*$, using a Monte Carlo approach where events are generated from the model and then analyzed as if they were experimental data. A partial-wave fit is made to the results of the calculation. The effect of absorption by the nuclear matter of the outgoing dipion system is estimated, and a brief effort is made to calculate $\pi^-C\to\pi^+\pi^-\pi^-C$, where the final state of C is not observed. (auth)

14025 MULTIPARTICLE PRODUCTION IN HIGH-ENERGY COLLISIONS: VALIDITY OF STATISTICAL AND HYDRODYNAMICAL APPROXIMATIONS. Nowakowski, J.;

Cooper, F. (Belfer Graduate School of Science, Yeshiva University, New York, New York 10033). Phys. Rev. D 9: No. 3, 771-775 (1 Feb 1974).

We discuss the conditions under which it is meaningful to use thermodynamics and hydrodynamics in describing the state of matter produced in high-energy collisions. We find that the criteria for neglecting quantum effects necessitate a minimum size for the system studied and are the same for using either thermodynamics or hydrodynamics. We also estimate, in the Fermi-Landau picture of proton-proton collisions, the fraction of time the collective state spends in the quantum phase. (auth)

14026 ASPECTS OF LOW-ENERGY NUCLEON–NUCLEON SCATTERING. Woloshyn, R. M. Stony Brook, NY; State University of New York (1973). 139p. University Microfilms Order No. 74-6761.

Thesis (Ph. D.).

The need to properly account for relativistic effects even when calculating low energy S-wave nucleon-nucleon phase shifts is outlined. A critical comparison of different relativistic three-dimensional approximations to the Bethe-Salpeter equation is made. The threshold value of the second Born term from different equations is calculated and compared with the exact relativistic results. Extensive numerical results are presented which indicate that, for a purely attractive interaction, the threshold value of the second Born term is a good indicator of how well a particular equation approximates the Bethe-Salpeter solution. The importance of the asymptotic behavior of the kernel of a relativistic equation for the nucleon–nucleon scattering amplitude in assuring solvability of the equation and in determining the value of the S-wave phase shift is outlined. The relativistic eikonal approximation is reviewed and a generalized one boson exchange amplitude with contributions from crossed ladder diagrams as well as vertex corrections is constructed in eikonal approximation. The connection between strong and electromagnetic interactions obtained through the eikonal approximation is used to constrain the parameters of the nucleon-nucleon interaction. The generalized one boson exchange model gives reasonable nucleon-nucleon phase shifts without recourse to ad-hoc form factors and arbitrary cut-off parameters. (Diss. Abstr. Int., B)

14027 APPLICATION OF THE GLAUBER APPROXIMATION TO ELEMENTARY PARTICLE COLLISIONS: MONTE CARLO EVALUATION OF GLAUBER TYPE INTEGRALS. Klenk, K. F. Bethlehem, PA; Lehigh Univ. (1973). 109p. University Microfilms Order No. 74-6686.

Thesis (Ph. D.).

The Glauber approximation is used to find the high energy proton-proton scattering amplitude assuming the proton to be composed of three quarks. The quark-quark scattering amplitude and proton density function are assumed to be Gaussian in form. With these assumptions all nine orders of multiple scatter can be calculated exactly. Results are compared to the Krisch compilation of the p-p data. Evidence for a third break and fourth slope region is presented and explained in the quark multiple scattering model as the effect of fourth and fifth order scatters. Also, the calculations for π-p and p-p scattering are done to all orders assuming further that the pion and antiproton density functions are Gaussians. The recent p-p data from the Intersecting Storage Rings (ISR) at very high energies are analyzed. The two most striking features, the concave structure of the forward peak and dips in the regions near $|t| = 1.2$ $(GeV/c)^2$ can be reproduced in the multiple quark scattering model provided that the quark-quark scattering amplitude be an undamped rapidly oscillating function of the momentum transfer. This implies that the quark-quark interaction is a point interaction and that production of free quarks will be suppressed. Monte Carlo methods are used to solve the many-dimensional integrals encountered in the calculation of the proton-proton scattering amplitude for the cases where the proton density function does and does not contain hard core factors. (Diss. Abstr. Int., B)

14028 REAL PART OF THE PROTON–PROTON FORWARD-SCATTERING AMPLITUDE FROM (50 TO 500) GeV. Pilachowski, L. (Univ. of Hawaii, Honolulu). Lett. Nuovo Cim.; 10: No. 7, 301-304(15 Jun 1974).

By using forward dispersion relations, the values of the total p + p cross sections above 50 GeV can be compared with the now available experimental data on the real part of the forward p + p scattering amplitude for incident laboratory energies from 50 to 400 GeV. (JFP)

14029 ENERGY DEPENDENCE OF FACTORIZABLE MODELS FOR ELASTIC SCATTERING. Henzi, R.; Margolis, B. (Department of Physics, McGill University, Montreal, Canada); Valin, P. Phys. Rev. Lett. 32: No. 19, 1077-1080 (13 May 1974).

We discuss properties of high-energy p–p scattering in terms of models where the eikonal is a function of energy times a function of impact parameter (factorizable models). Using the eikonal determined from the data at one fixed energy, we deduce that the secondary diffraction maximum should rise with increasing energy if the total cross section rises. Further data, from National Accelerator Laboratory energies and up, would be of interest to decide for or against factorizable models. (auth)

14030 NUCLEAR COLLISIONS AND FACTORIZATION. Franco, V. (Physics Department, Brooklyn College of the City University of New York, Brooklyn, New York 11210). Phys. Rev. Lett. 32: No. 16, 911-913 (22 Apr 1974).

Total cross sections for nucleon–α and $\alpha\alpha$ collisions are calculated for $86 < s < 2776$ GeV^2 in the Glauber approximation. The results are compared with those obtained by assuming factorization for the Pomeron. Calculations for $s > 2776$ GeV^2, with simple assumptions regarding nucleon–nucleon elastic collisions, are also given. For $100 < s < 2776$ GeV^2, where NN data exist, the Glauber-approximation results differ from the factorization predictions by ~4–10%. At higher energies the factorization predictions are approached slowly. (auth)

14031 SEMI-INCLUSIVE DEEP-INELASTIC SCATTERING AND PRODUCTION OF μ PAIRS IN PP COLLISIONS IN THE MASSIVE-QUARK MODEL. Gatto, R. (Istituto di Fisica dell'Università di Roma, Roma, Italy); Preparata, G. Phys. Rev. D 9: No. 7, 2104-2111 (1 Apr 1974).

This paper contains the massive-quark-model (MQM) discussion of one-particle inclusive deep-inelastic scattering (DIS) and of the production of massive μ pairs in pp collisions. (auth)

14032 MULTIPLE SCATTERING THEORY WITH PROPER WAVE FUNCTION SYMMETRY APPLIED TO PION–DEUTERON SCATTERING AT THRESHOLD. Bendix, P. B. Vancouver, B. C.; Univ. of British Columbia (1973). National Library of Canada, Ottawa.

Thesis (Ph. D.).

The scattering amplitude for pions on deuterons is calculated in the threshold limit using Watson's multiple scattering theory. Care is taken to use wave functions with proper symmetry throughout, and it is shown that the results are identical with those obtained using unsymmetrized wave functions in intermediate states. Terms up to second order in the multiple scattering series are calculated, gradually increasing the complexity of the assumptions until all quantitatively relevant features are taken into account. Specifically, single scattering, double elastic scattering, double charge-exchange scattering, and second order binding correction terms are treated. New quantitative results are obtained which account for nonzero binding energy of the deuteron and ·nd nucleon excitation in the propagators, Lorentz-invariant and ·nelastic scattering kinematic factors in the two-body scattering amplitudes phase-shift fitted pion-nucleon scattering amplitudes up to P-waves, an S-wave Gartenhaus deuteron wave function, and relativistic effects in high momentum intermediate states. In addition, a general method utilizing graphs analogous to Feynman diagrams is presented which easily reproduces each order contribution of the multiple scattering series (for constant two-body T matrices) and allows one to sum the whole series in closed form. In particular, the sum of the whole series is found for π^--deuteron scattering at threshold, including all isospin-flipping terms, a result incorrectly obtained in previous literature. Also the series sum for π^- scattering on an arbitrary nucleus of neutrons and protons, including charge-exchange scattering is found. (This result does not appear in the literature). From the series sum one then calculates the higher-order contribution with a Hulthen and then a Gartenhaus S-wave deuteron wave function, first neglecting charge–exchange and then including it. The higher-order contribution is found to be roughly twenty per cent of the first and second order terms combined (at threshold). The best estimate of the pion-deuteron scattering amplitude at threshold (the pi–d scattering length) is $F_{sl} = -.0273$ fermis. Because pion-deuteron scattering is a three-body problem and because of the similarities with multiple scattering theory, a short discussion of the Faddeev equations is included. Particular emphasis to wave function symmetry in the Faddeev approach is given. (Diss. Abstr. Int., B)

14033 MULTIPERIPHERAL MODEL AT ULTRAHIGH ENERGIES. Jha, S. K. (Univ. of Delhi); Shivpuri, R. K. Particles Nucl.; 7: No. 1-2, 22-28(1974).

It was shown that at ultrahigh energies (~10^{12} eV) the multiperipheral model which assumes the exchange of a schizophrenic pomeron is inadequate to explain the interaction characteristics which had earlier led to the fireball model. The various experimental parameters discussed are the longitudinal momentum distribution, neutral particle production and the angular distribution of the secondary particles. (auth)

14034 DIFFRACTIVE FIREBALL PRODUCTION AND RISING TOTAL CROSS SECTIONS AT HIGH ENERGIES. Peierls, R.F.; Wang, L. (Brookhaven National Laboratory, Upton, New York 11973). Phys. Rev. D 9: No. 9, 2495-2501 (1 May 1974).

We calculate the contribution of single, double, and multiple diffractive fireball production to the proton–proton total cross section at high energy. A diffractively produced fireball is a cluster of particles whose rapidity separation from adjacent particles exceeds some specified threshold. Only that part of the fireball mass distribution which is governed by the Pomeron trajectory is included. The numerical result is controlled by the triple–Pomeron coupling. The multiple–fireball contribution is obtained by summing all contributions into an integral equation whose solution gives a complex trajectory which we calculate. Each fireball multiplicity gives a rising contribution at first which damps out at higher energies. The sum may give an oscillating contribution. The sensitivity to the parameters is discussed. We find that only the single–fireball term can be significant at CERN ISR energies and can not be sufficient to explain the observed rise; correspondingly, the leading complex pole is very low. (auth)

14035 RAPID MULTIPLICITY RISE AS A FUNCTION OF MOMENTUM TRANSFER IN MULTICOMPONENT MODELS. Gutay, L.J. (Brookhaven National Laboratory, Upton, New York 11973); Suranyi, P. Phys. Rev. D 9: No. 9, 2501-2504 (1 May 1974).

It is shown that the average multiplicity exhibits a rapid rise as a function of t (the momentum transfer between the initial and leading particle) in multicomponent models in marked contrast to multiperipheral models where a slow decrease is predicted. (auth)

14036 POSSIBLE RELATIONSHIP BETWEEN THE RATIO π^+/π^- AND THE AVERAGE MULTIPLICITY. Chao, A.W.; Yang, C.N. (Institute for Theoretical Physics, State University of New York, Stony Brook, New York 11790). Phys. Rev. D 9: No. 9, 2505-2512 (1 May 1974).

If charge distribution in a collision process becomes "statistical," then the ratio π^+/π^- could be used to measure the average multiplicity. A detailed mathematical analysis is given as well as a discussion of physical limitations. (auth)

Particle Invariance Principles and Symmetries

General

Refer also to abstracts 13967, 14076, and 14468.

14037 (COO-3069-190) DYNAMICAL SYMMETRY BREAKING. Jackiw, R. (Massachusetts Inst. of Tech., Cambridge (USA)). Jul 1973. 23p. Dep. NTIS $4.25.

Different examples of the Schwinger mechanism are discussed; that is, three different circumstances which lead to a pole in $\pi(q^2)$ are presented. They are the Schwinger example of two-dimensional massless spinor electrodynamics, the Higgs mechanism, and one based on a bound state mechanism for symmetry breaking. (JFP)

14038 QUARKS: CURRENTS AND CONSTITUENTS. Melosh, H.J. (Enrico Fermi Institute, University of Chicago, Chicago, Illinois 60637). Phys. Rev. D 9: No. 4, 1095-1112 (15 Feb 1974).

An attempt is made to clarify the relation between current quarks and constituent quarks. Assuming that the two are related by a unitary transformation, we outline the properties of this transformation and, in the process, discover a new U(6) × U(6) × O(3) classification algebra for the hadrons. An example of this transformation is constructed in the lightlike–plane formulation of the free-quark model, where the transformation is found to be essentially unique and is just the operator solution to the problem of saturating chiral SU(3) × SU(3). Using the algebraic structure of the free-quark model phenomenologically, matrix elements of currents between different hadrons are related. This abstraction of free-quark algebraic properties works fairly well for the axial-charge and magnetic-moment operators, although it fails for bilocal operators. Nevertheless, we obtain many successful approximate relations between matrix elements of currents, not the least of which is the recovery of the ratio $\mu_T(\text{proton})/\mu_T(\text{neutron}) = -3/2$. (auth)

14039 CHIRAL $SU_4 \otimes SU_4$ AND SCALE INVARIANCE. Hu, B. (Laboratory of Nuclear Studies, Cornell University, Ithaca, New York 14850). Phys. Rev. D 9: No. 6, 1825-1834 (15 Mar 1974).

Proceeding from the speculation that the real world is approximately $SU_4 \otimes SU_4$–and scale-invariant, we study the mechanism of spontaneous breakdown by considering a σ-type model that embodies both operator partial conservation of axial-vector current and operator partial conservation of dilation current. Solutions exhibiting spontaneous breakdown are analyzed in relation to the behavior of transition when explicit symmetry breaking is turned on. Allowed domains for the symmetry-breaking parameters are also derived. (auth)

14040 SCALE- AND CHIRAL-SYMMETRY BREAKING IN A THRESHOLD-DOMINANT FRAMEWORK. Katz, J.; Tatur, S. (Institute für Theoretische Physik, Freie Universität Berlin, Berlin, Germany). Phys. Rev. D 9: No. 8, 2391-2396 (15 Apr 1974).

We make use of the Li-Pagels mechanism to investigate meson and baryon elements of the trace of the energy–momentum tensor $T_\mu{}^\mu$ as well as of the chiral-symmetry-breaking Hamiltonian u. We show that both $T_\mu{}^\mu$ and u are sums of a unitary singlet and the eighth component of an octet. Moreover, it is seen that a q-number δ [i.e., a q-number term breaking scale invariance but not SU(3) $\otimes$SU(3)] is present in the decomposition of $T_\mu{}^\mu$. Furthermore, a relation between the matrix elements of each of the parts of $T_\mu{}^\mu$ and u is established and all of these matrix elements are completely determined. We conclude with a discussion of vector-meson matrix elements in this framework. (auth)

14041 SPONTANEOUS SYMMETRY BREAKING, GAUGE THEORIES, THE HIGGS MECHANISM AND ALL THAT. Bernstein, J. (Stevens Institute of Technology, Hoboken, New Jersey). Rev. Mod. Phys. 46: No. 1, 7-48 (Jan 1974).

A more or less self-contained introductory review is presented of the so-called Higgs phenomenon. This is the mechanism by which, in a certain class of gauge theories, the "photon" and would-be Goldstone scalar mesons conspire together to produce massive vector mesons via a "spontaneous" breaking of gauge invariance. It is conceivable that this is the way in which nature has chosen to unify weak and electromagnetic interactions. It is hoped that a reader of this review will come to understand the meaning of the first three sentences in this abstract, and will then be able to proceed to confront a rapidly growing literature in the subject of gauge theories. (auth)

14042 NONLINEAR TRANSFORMATIONS IN VECTOR SPACES. Colineation and Conformal Groups. Tilgner, H. (Freie Univ., Berlin). J. Math. Phys. (N.Y.); 15: No. 3, 360-366(Mar 1974).

The sets of special colineations and conformal transformations of a pseudo-orthogonal vector space can be given only a Lie groupoid structure, rather than a Lie group structure because of the nonvanishing denominators. With every such groupoid one can associate a unique Lie group, which, however, no longer consists of transformations. For one-parameter subgroups one can define infinitesimal transformations and a bilinear composition, called Lie bracket, which reduces for linear transformations to the commutator. In the special cases of colineations and conformal transformations on pseudo-orthogonal vector spaces of arbitrary finite dimension and signatures, covering homomorphisms onto matrix groups are given together with the corresponding Lie algebra isomorphisms. (auth)

14043 ALGEBRAICALLY IRREDUCIBLE REPRESENTATIONS OF THE LIE ALGEBRA sl(2). Arnal, D.; Pinczon, G. (Univ., Dijon, France). J. Math. Phys. (N.Y.); 15: No. 3, 350-359(Mar 1974).

An algebraic study of the irreducible representations of the complex Lie algebra sl(2) is presented. This study generalizes a former series of works of W. Miller. Though the list is not complete, it gives hints as to the construction of a very vast family of representations. (auth)

Applications (Electromagnetic and Weak)

Refer also to abstracts 13927, 13936, 13942, 14194, and 14467.

14044 ALGEBRAIC REALIZATION OF SU(6)$_{W,\text{currents}}$ CHARGE-ALGEBRA SUM RULES. Horwitz, B. (Department of Physics, University of Pennsylvania, Philadelphia, Pennsylvania 19104). Phys. Rev. D 9: No. 4, 996-1003 (15 Feb 1974).

Using the technique of Fubini and Furlan we extend the algebraic relations for chiral SU(2) $\otimes$ SU(2) obtained by Weinberg to the larger algebra formed by including tensor charges. Hence, we deal with the "good" charges of SU(12). The relations we derive are algebraic conditions for vector-meson-hadron decay amplitudes. These conditions enable one to obtain relationships between states of different helicity.

14045 BROKEN SU(4) $\otimes$SU(4) SYMMETRY. Dicus, D.A.; Mathur, V.S. (Department of Physics and Astronomy, University of Rochester, New York 14627). Phys. Rev. D 9: No. 4, 1003-1017 (15 Feb 1974).

Starting with chiral SU(4) $\otimes$SU(4) invariance realized in the Nambu–Goldstone manner, with the vacuum invariant under SU(3), we discuss in this paper the various implications of explicit symmetry-breaking terms that transform as the $(4,4^*) \otimes (4^*,4)$ representation. The motivation for this work comes from recent investigations in connection with the unified gauge theories, which

suggest the relevance of SU(4) ⊗SU(4) symmetry of strong interactions with (4,4 *)⊕(4*, 4) breaking. The domain structure for the allowed values of the symmetry-breaking parameters is discussed in analogy with a similar investigation for the SU(3) ⊕SU(3) theory, and the ratio of charmed- to uncharmed-particle masses is derived in terms of these parameters. Solutions are sought for these parameters through an analysis of the η-χ and η-χ-E mixing problems, as well as η,χ → 2γ decays. Within the framework of our assumptions, we are unable to obtain a solution that agrees with the recent results discussed by Dittner et al. on the basis of a hadron-lepton analogy.

14046 SU(4) ⊗SU(4) AS AN APPROXIMATE SYMMETRY OF HADRONS. Prasad, S.C. (Department of Physics and Astronomy, University of Rochester, Rochester, New York 14627). Phys. Rev. D 9: No. 4, 1017-1022 (15 Feb 1974).

The (4,4 *) + (4 *, 4) model of broken SU(4) X SU(4) as an approximate symmetry of hadrons is investigated. Spectral-function sum rules for scalar and pseudoscalar densities are derived in this model. Sum rules based on octet-type breaking of SU(3) at $q^2 = 0$ and $q^2 = \infty$ are also obtained. It is shown that the $q^2 = 0$ sum rule out SU(2) ⊗ SU(2) as a good symmetry of the Hamiltonian, when the vacuum is approximately SU(3) -invariant, in the present model. Thus the problem of understanding SU(2) ⊗SU(2) and SU(3) as approximate symmetries of the Hamiltonian persists as in the case of the popular (3,3 *) + (3*, 3) model of broken SU(3) X SU(3). It is shown that the $q^2 = \infty$ sum rule is consistent with the idea that SU(2) X SU(2) is a good symmetry of the Hamiltonian. A mass formula for charmed pseudoscalar mesons is also derived. (auth)

14047 OFF-MASS-SHELL PARITY-VIOLATING PION-NUCLEON INTERACTION. II. APPLICATIONS. Henley, E.M.; Keliher, T.E. (Physics Department, University of Washington, Seattle, Washington 98195); Pardee, W.J.; Yu, D.U.L. Phys. Rev. D 9: No. 3, 755-764 (1 Feb 1974).

Parity-violating effects in the capture reaction $\pi^- + p \rightarrow \gamma + n$ for pions at rest and in the elastic scattering of pions from nucleons are suggested as possible tests of the weak off-mass-shell pion-nucleon vertex, $G_{\pi NN}$, proportional to $\cos^2\theta$, where θ is the Cabibbo angle. The on-mass-shell vertex proportional to $\cos^2\theta$ vanishes if CP is conserved. Effects of the $\sin^2\theta$ term and of a parity-violating ρ-nucleon coupling are included. The two-pion exchange force due to $G_{\pi NN}$ is also investigated. (auth)

14048 GAUGE-INVARIANT THEORY OF CP NONINVARIANCE. Hsu, J.P. (Center for Particle Theory, University of Texas at Austin, Austin, Texas 78712). Phys. Rev. D 9: No. 3, 810-812 (1 Feb 1974).

We discuss a renormalizable theory of violations of CP and T invariance. The dynamics of CP violation is completely determined by the principle of minimum gauge-invariant interaction. The experimental tests of the theory are also considered. (auth)

14049 ESTIMATE OF CORRECTIONS TO THE DASHEN-WEINSTEIN THEOREM. Kenny, B.G.; Kac, M. (Research School of Physical Sciences, The Australian National University, Canberra, Australia). Phys. Rev. D 9: No. 3, 826-829 (1 Feb 1974).

Corrections to the Dashen-Weinstein theorem are obtained assuming a specific model for the chiral-symmetry-breaking Hamiltonian. It is noted that standard pole-model results are recovered if an additional simplifying assumption is made. (auth)

14050 ηX MIXING AND CHIRAL-SYMMETRY BREAKING II. Kenny, B.G. (Research School of Physical Sciences, The Australian National University, Canberra A.C.T., 2600, Australia). Phys. Rev. D 9: No. 9, 2677-2679 (1 May 1974).

An earlier argument suggesting that the η-X mixing angle vanishes is generalized. This theoretical conclusion is supported by a recent measurement of the decay rate η → 2γ. (auth)

Applications (Strong)

Refer also to abstracts 13952, 13970, 13986, 14013, and 14168.

14051 STRONG DECAYS OF BARYONS AND RESONANCES IN A FORMALISM OF CROSSING-SYMMETRIC FORM FACTORS. Parashar, D. (Department of Physics and Astronomy, University of Hawaii, Honolulu, Hawaii 96822); Katyal, D.L. Phys. Rev. D 9: No. 5, 1420-1424 (1 Mar 1974).

Starting with relativistic form of the hadron couplings in the SU(6) ⊗ O(3) quark model, we calculate the strong decay widths and branching ratios of baryons and their resonances within the framework of a set of three crossing-symmetric form factors. The parametric structure of the form factors, used in this paper, is obtained in a phenomenological way essentially to accord with certain important properties, such as Lorentz invariance, crossing symmetry (in hadron 4-momenta and physical masses), and Regge universality of hadron couplings. A comparative study of all three form factors is made to assess their respective roles in bringing about quantitative agreement with the available experimental data. One of the form factors, f^{III}_L, seems to have the maximum coverage in terms of over-all agreement with the experimental estimates, especially with reference to the decay ratios of Regge recurrences of the Δ (1236). (auth)

14052 TRANSFORMATION BETWEEN CURRENT AND CONSTITUENT QUARKS AND TRANSITIONS BETWEEN HADRONS. Gilman, F.J. (California Institute of Technology, Pasadena, California 91109); Kugler, M.; Meshkov, S. Phys. Rev. D 9: No. 3, 715-735 (1 Feb 1974).

The transformation from current- to constituent-quark basis states is discussed. Certain algebraic properties of the transformed vector and axial-vector currents are abstracted from the free-quark model and assumed to hold in nature. Supplemented by the partially conserved axial-vector current and assumptions about the identification of the observed hadrons with simple constituent-quark states, the algebraic properties of the transformed currents are used to compute the pion and photon transitions between any two hadron states. General selection rules are stated. Many specific matrix elements for both meson and baryon decays are tabulated, and both their magnitudes and signs are compared with experiment. (auth)

14053 INVESTIGATIONS IN AN SU(3) SIGMA MODEL. Hudnall, W. R. Jr. New York; Syracuse Univ. (1973). 140p. University Microfilms Order No. 74-10,148.

Thesis (Ph. D.).

Several investigations were performed in the tree approximation of a linear SU(3) sigma model of strong interactions. The Lagrangian of the generalized sigma model which contains eighteen 0^+ fields interacting via the most general chiral SU(3) × SU(3) invariant, parity and charge conjugation conserving form is adopted. The original model contains two interesting features: an explicit (3*,3) + (3,3*) symmetry breaking term and a mechanism for allowing spontaneous breakdown of some of the original symmetry. Both of these features are related via chiral invariance to the masses and the coupling constants in the theory. The currents and field-current identity calculable from the model are applied to the prediction of the K_{l3} parameters. Since the actual $K^*K\pi$ coupling constant is determined by the model, the results are a considerable improvement over the results of previous current algebra calculations. We first apply this renormalized SU(3) sigma model to the decay $\eta' \rightarrow \eta\pi^+\pi^-$ which involves the trilinear couplings of isoscalar 0^+ mesons and find that we can fit the dipion invariant mass distribution for the process although there is disagreement with the experimentally determined parameter of the linear fit. Also the effective electromagnetic process $\eta \rightarrow \pi^+\pi^-\pi^0$ is considered in the renormalizable SU(3) model. The prediction gives the correct order of magnitude for this process. The usual π^0-η mixing term in the matrix element is related to the $K^+ - K^0$ mass shift and, in addition, find another term resulting from the mixing of the analogous scalar mesons. (Diss. Abstr. Int., B)

14054 MASSIVE SPIN 2 PARTICLES FROM SPONTANEOUSLY BROKEN SYMMETRIES. Dondi, P. H. (Univ., Karlsruhe, Ger.). J. Phys., A (London); 7: No. 6, L73-L74(11 Apr 1974).

It is demonstrated how a spontaneously broken gauge symmetry can be used to produce a massive, gauge invariant, spin 2 theory. (auth)

14055 SYMMETRIC-GROUP CONSTRUCTION OF A NEW MULTIPARTICLE BORN AMPLITUDE FOR PHYSICAL PIONS. Frampton, P.H. (Physics Department, Syracuse University, Syracuse, New York 13210). Phys. Rev. D 9: No. 2, 487-497 (15 Jan 1974).

In this paper a many-pion tree amplitude is constructed as an extension of a four-pion amplitude previously suggested. That four-pion amplitude had the properties of no odd daughters and an integrand with symmetric-group invariance; in addition, it seemed to be ghostfree at the two-body level and to be phenomenologically superior to competing physical models without invariance under the symmetric group. The new multipion amplitude has different leading intercepts $\alpha_\rho(0)$ and $\alpha_\pi(0)$ in the even and odd G-parity channels, respectively; these intercepts have half-integer spacing $\alpha_\rho(0)-\alpha_\pi(0) = 1/2$, but are otherwise unconstrained. The amplitude is presented in two equivalent forms: The first uses partial differential operators, treating all differences between Koba-Nielsen variables as linearly independent; the second makes use of a set of N complex variables satisfying a Grassmann algebra. It is shown that the six-pion amplitude satisfies bootstrap consistency at the internal pion pole. It is pointed out that the amplitude satisfies a higher symmetry, spin-lowering symmetry, in addition to the symmetric-group invariance used in its construction. Spin-lowering symmetry is associated with the tachyon-eliminating factors for the ρ trajectory, and remarkably provides the mechanism for decoupling an unwanted ancestor state one spin unit above the pion trajectory. Apart from the proof of bootstrap consistency at N = 6, factorization of the multiparticle amplitude is not discussed. (auth)

14056 COPLANAR BREAKING OF SU(6)$_W$ APPLIED TO PIONIC DECAYS OF THE BARYONS (L=1). Haut, H.; Leroy, C.; Van Parijs, J. (Institute of Theoretical Physics, University of Louvain, Belgium). Phys. Rev. D 9: No. 8, 2385-2390 (15 Apr 1974).

Coplanar symmetry is used as a way to break $SU(6)_w$. A classification scheme for baryons in $U(3) \times U(3)_{\rho\sigma_y}$ is given and pionic decay amplitudes for the baryons (L = 1) are computed. (auth)

14057 CHIRAL MAGNETISM (OR MAGNETOHADROCHIRONICS). Casher, A.; Susskind, L. (Tel Aviv University Ramat Aviv, Tel-Aviv, Israel). Phys. Rev. D 9: No. 2, 436-460 (15 Jan 1974).

In the infinite-momentum frame a hadron may be viewed as a one-dimensional stringlike structure composed of many constituents. We consider the dynamics of such a system and show how a spontaneous breakdown of chiral symmmetry may occur. The effect is very similar to ferromagnetism. We formulate the theory of the distribution of quantum numbers in hadrons and establish the relation between this theory, chiral magnetism, soft-pion theorems, Regge behavior, and duality. In particular we show how the Harari-Gilman-Weinberg theory of chiral representation mixing follows from an approximation analogous to the treatment of a magnetic impurity in a ferromagnetic system. The first stage of approximation, when applied to a quark-parton system leads to a $\bar{q}q$ meson model. We demonstrate the need for spin-orbit coupling in the infinite-momentum quark system. Higher approximations are expected to lead to exotic states. A necessary consequence of our theory of spontaneous chiral-symmetry breakdown is the existence of a Pomeron-like vacuum trajectory with unit intercept. The natural order of magnitude of high-energy meson-meson total cross sections turns out to be $f_\pi^{-2} = 10$ mb, as conjectured by Pagels. A specific model included in an appendix yields $\sigma_{tot}(\pi\pi) = 2f_\pi^{-2}$. We do not explicitly deal with strangeness, or SU_3. (auth)

14058 BROKEN CHIRAL SYMMETRY OF HADRONS. Prasad, S.C. (Department of Physics and Astronomy, University of Rochester, Rochester, New York 14627). Phys. Rev. D 9: No. 2, 500-503 (15 Jan 1974).

New spectral-function sum rules for the pseudoscalar density in the $(3,3^*) \oplus (3^*,3)$ model of broken $SU(3) \oplus SU(3)$ are derived. It is shown how the sum rules provide useful constraints on the symmetry-breaking parameters and give new insight into the breaking chain of chiral symmetry. (auth)

14059 B $\omega\pi$ DECAY AND SU(3) BREAKING. Brout, R.; Englert, F.; Truffin, C. (Faculté des Sciences, Université Libre de Bruxelles, Bruxelles, Belgium). Phys. Rev. D 9; No. 9, 2694-2695 (1 May 1974).

We review the argument for the decoupling of the B ω π decay in the longitudinal mode through the mechanism of SU(3) breakdown in dual schemes. (auth)

14060 PREDICTION OF THE SU(3) ⊗ SU(3) CONFIGURATION MIXING AS A RELATIVISTIC EFFECT IN THE NAIVE QUARK MODEL. Le Yaouanc, A.; Oliver, L.; Pène, O.; Raynal, J.C. (Laboratoire de Physique Théorique et Hautes Energies Université de Paris-Sud, Bât. 211, 91405, Orsay, France). Phys. Rev. D 9: No. 9, 2636-2645 (1 May 1974).

The harmonic-oscillator quark model of hadrons implies relativistic internal velocities for the quarks. If, consequently, we use a relativistic treatment of the quark spin (by replacing Pauli spinors with Dirac spinors), we obtain not only corrections to the "static SU(6)" results for the axial-vector matrix elements G_A/G_V or G^* (as shown by Bogoliubov), but the whole $SU(3) \otimes SU(3)$ configuration mixing at $p_z = \infty$, in a semiquantitative manner. The mixing operator is just the product of the Wigner rotations of quark spins. For the low-lying $1/2^+$ octet, the dominant representations are (6, 3), (3, $\bar{3}$), and (8, 1), in agreement with the phenomenological analysis of Buccella, De Maria, and Lusignoli. The SU(6) classification of hadrons is preserved; at rest, the hadron wave function corresponds to an SU(6) group whose spin generators are the sum of the mean spin operators (of Foldy and Wouthuysen) of the quarks. (auth)

Scattering Theory

Refer also to abstracts 13719 and 13971.

14061 (JINR-P2-7976) LOCAL STUDY OF REST POINTS OF THE CHEW–LOW TYPE EQUATION. Gerdt, V. P.; Meshcheryakov, V. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 20p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

The method of investigating the Chew–Low equations suggested earlier is applied to the crossing-symmetry matrix A(1,1). It is based on the use of a number of notions from the theory of differential equations, such as stationary point, invariant manifold, etc. The vicinities of the stationary points of a system of autonomous nonlinear difference equations for this matrix are considered. They are studied on the basis of an abelian one-parameter group of continuous transformations which is associated with the initial difference equations. The detailed quantitative picture of invariant curves can be obtained from group differential equations. In the vicinity of a degenerate stationary point (X = Y = 1, §3), being of most physical interest, the first normal integral of group differential equations is found. The invariant curves can approach the degenerate stationary point only along definite directions. These directions are indicated by some invariant curves which separate sets of curves with different properties. The structure of hyperbolic stationary points $\alpha_0 - 1$ and $(X_0 - 1)$ is clarified and the appropriate invariant curves passing through these points are plotted. The geometrical interpretation of invariant curves on the phase plane makes the following statement obvious: Solutions with the Born term and correct threshold behavior are absent. (auth)

14062 COORDINATE ASYMPTOTICS OF THE SOLUTION OF SCATTERING PROBLEM FOR THE SCHROEDINGER EQUATION. Buslaev, V. S.; Skriganov, M. M. (Leningrad State Univ.). Teor. Mat. Fiz.; 19: No. 2, 217-232(May 1974). (In Russian).

An asymptotic expansion of the scattering solution of the Schrödinger equation at $x \to \infty$ is considered. It is assumed that the potential does not oscillate and decreases at infinity faster than the Coulomb potential. The asymptotic expansion includes special functions. Singularities of the forward scattering amplitude are described. (auth)

14063 UNDERSTANDING s-CHANNEL PARTIAL-WAVE AMPLITUDES IN TWO-BODY SCATTERING. Stevens, P.R. (Department of Physics, University of California, Riverside, California 92507). Phys. Rev. D 9: No. 5, 1425-1434 (1 Mar 1974).

We study in detail the s-channel partial-wave amplitudes for vector- and tensor-exchange amplitudes by comparing the results of seven different, quantitatively successful phenomological analyses. We consider separately the partial waves in the peripheral region, where Regge poles alone should dominate, and in the central region, where Regge cuts may also be important. We show that these regions separately show interesting regularities which are not evident when the amplitudes are plotted as functions of t. We point out difficulties with individual analyses which help explain the discrepancies between their findings. We show that the existing analyses are consistent with the assumption that the Regge poles are approximately exchange-degenerate and that exchange-degeneracy breaking occurs mainly at small impact parameter. (auth)

14064 SINGULARITIES IN THREE-BODY FINAL-STATE AMPLITUDES. Adhikari, S.K.; Amado, R.D. (Department of Physics, University of Pennsylvania, Philadelphia, Pennsylvania 19174). Phys. Rev. D 9: No. 5, 1467-1475 (1 Mar 1974).

Three-body amplitudes have two-body threshold singularities over and above those coming from the usual treatments of final-state interactions. These are analyzed both formally and numerically. In the numerical model studies, they account for an important variation of the amplitude. The singularity comes from the "next to last" rescattering, and hence, may be represented correctly by any approximate amplitude that has that rescattering, even if the approximation scheme diverges. This may account for the correct shape (not magnitude) of multibody spectra determined with a divergent multiple-scattering series. (auth)

14065 FRAGMENTATION IN THE EIKONAL PICTURE. Blankenbecler, R. (Stanford Linear Accelerator Center, Stanford, California 94305); Fulco, J.R.; Sugar, R.L. Phys. Rev. D 9: No. 3, 736-743 (1 Feb 1974).

The eikonal approach to the scattering and production of high-energy particles is reviewed and extended. Several models for the high-energy behavior of the eikonal phase are discussed. We show how to introduce effects associated with the fragementation of the incident particles into the eikonal framework, and indicate how these effects can influence the energy dependence of cross sections. The contributions of the triple-Regge region of phase space to the amplitude are examined. The importance of absorptive effects is clearly shown by demonstrating that the sign of the term linear in the triple-Pomeron coupling is negative in the total cross section. (auth)

14066 SEPARABLE REPRESENTATIONS OF T MATRICES VALID IN THE VICINITY OF OFF-SHELL POINTS. Ernst, D.J.; Shakin, C.M.; Thaler, R.M. (Department of Physics, Case Western Reserve University, Cleveland, Ohio 44106). Phys. Rev. C 9: No. 5, 1780-1783 (May 1974).

The method developed in a previous paper for the construction of separable representations for T matrices is extended. It is shown that the separable representation we propose is valid in the vicinity of specified off-shell points. Since the off-shell points considered include those with arbitrary negative-energy parameters, the method presented here should be of value for the bound-state three-body problem. (auth)

14067 EIGENVALUES OF THE FADDEEV EQUATIONS WITH REPULSIVE TWO-BODY INTERACTIONS. Harms, E. (Department of Physics, Fairfield University, Fairfield, Connecticut 06430). Phys. Rev. D 9: No. 4, 993-995 (15 Feb 1974).

The attractive (positive) and repulsive (negative) linear eigenvalues of the Lippmann–Schwinger equation can become arbitrarily small in

absolute value for sufficiently strong interactions. In this paper we show that this cannot be the case for the Faddeev equations. Three-body eigenvalues arising from the repulsive part of the two-body interaction must have a certain minimum absolute value or the Faddeev equations can predict physical bound states held together by this part of the interaction. It is shown that this limitation upon the eigenvalues arises from the suppression in the T matrix of the repulsive part of the two-body potential. (auth)

14068 VARIATIONAL UPPER BOUND ON THE SCATTERING LENGTH. Gelman, D. (Department of Physics, C. W. Post College, Greenvale, New York 11548). Phys. Rev. D 9: No. 4, 931-933 (15 Feb 1974).

Previous work on the application to scattering theory of the Feynman path-integral formulation of nonrelativistic quantum mechanics is extended. By using the regularization $\mathrm{Tr}(e^{-\beta H} - e^{-\beta H^0})$ of the divergent partition function $\mathrm{Tr}e^{-\beta H}$, where H^0 is the free-particle Hamiltonian, $H = H^0 + V$, and V is a short-range potential of the form $V(\vec{r})$ which cannot support a bound state, we obtain a variational upper bound on the scattering length. This bound is expressed in terms of path integrals containing a trial functional $\tilde{S}$, and reduces to the natural analog of the Rayleigh-Ritz result when $\tilde{S}$ is of the standard form $-\int[E_K) + \tilde{V}]dt/\hbar$, with E_K the kinetic energy and $\tilde{V}$ a trial potential. Since S need not be of this form, the bound contains new features. (auth)

14069 POLYÀ DISTRIBUTION IN A PARTON DESCRIPTION OF HIGH-ENERGY SCATTERING. Chang, L. (Department of Physics, University of Pennsylvania, Philadelphia, Pennsylvania 19104); Chang, N. Phys. Rev. D 9: No. 3, 660-666 (1 Feb 1974).

We derive a multiplicity distribution law based on parton model ideas and asymptotic Koba-Nielsen-Olesen scaling. Specifically, the Polyà distribution is found to result if one demands consistency among Feynman-Yang scaling, a linear fit to the Wroblewski plot, and independent emission of secondaries. A comparison with data is presented. (auth)

14070 LONG-RANGE TAIL PRODUCED BY THE CDD AMBIGUITY IN A STATIC MODEL. Weiss, J. (Technical Univ., Bratislava). Czech. J. Phys.; 24: No. 2, 146-160(1974).

An aspect of a potential-model analogy of the customary CDD ambiguity is studied. Starting from the idea that the known CDD ambiguity in the S-matrix produces an ambiguity in the determination of potentials, the influence of CDD poles upon the long-range behavior of potentials in the relativistic (Klein-Gordon) static model is demonstrated. Generation of the long-range tail by CDD poles is investigated in terms of a scattering inversion-problem formalism, based on the N/D equations extended off the mass shell. (auth)

14071 PLANE-WAVE APPROXIMATION IN THE S-MATRIX AND THE CONSTRUCTION OF BOUND-STATE WAVE FUNCTIONS. Weiss, J. (Technical Univ., Bratislava). Czech. J. Phys.; 24: No. 2, 125-145(1974).

Three inversion problem approaches—by GELFAND-LEVITAN, MARCHENKO and PETRAS—in both nonrelativistic and relativistic (Klein-Gordon) variants are used in an approximation scheme selected to construct bound-state wave functions which are advantageous for purposes of model hadron physics. This family of wave functions is created exclusively by the S-matrix quantities and derived in the approximation which requires the Jost function to be equal to unity throughout the continuous spectrum (the plane-wave approximation). As a consequence of the difference in boundary conditions of the mentioned approaches, the resulting approximate wave functions are not identical, but is is shown that there exists a parallelism as to the form among them. This parallelism is explained more extensively in the nonrelativistic case, where the transformation properties of alternative sets of functions are treated. It is demonstrated that in the relativistic variants of the above approaches the nonrelativistic plane-wave-approximation form of the constructed wave functions for a given bound state is preserved. (auth)

14072 IMPACT PARAMETER REPRESENTATION FOR FORWARD AND BACKWARD SCATTERING OF TWO PARTICLES. Allerton, J. M.; Bhakar, B. S. (Univ. of Manitoba, Winnipeg). Can. J. Phys.; 52: No. 9, 830-837(1 May 1974).

The Lippman-Schwinger equation is solved to obtain an impact parameter representation for the forward and backward scattering. The Blankenbecler and Goldberger type amplitude is obtained in the high energy limit without any angular restriction. Then, the off energy shell amplitude in the forward and backward cone is obtained, which reduces to Glauber form on the energy shell. Finally, unitarity restriction and the scope of the formalism are discussed. (auth)

14073 BOUNDS ON MULTIPLICITIES AND POLYNOMIAL BOUNDEDNESS. Khuri, N.N. (Rockefeller University, New York, New York 10021). Phys. Rev. D 9: No. 6, 1802-1809 (15 Mar 1974).

We prove that in any "model" or "theory" in which (a) perturbation expansions have a finite radius of convergence, (b) the cross sections for producing n hadrons, $\sigma_n(s,\lambda)$, are polynomially bounded, $|\sigma_n(s,\lambda)| \leq s^N$, for all values of the coupling constant λ inside the circle of convergence, with N independent of n, the following bounds on the average multiplicities hold for large s: $\langle n\rangle \leq C\ln s$ and $\langle n^p\rangle \leq C^p(\ln s)^p$. In proving this result we also use the Jin-Martin lower bound for physical λ, $\sigma_{tot}(s,\lambda) \geq (\text{const})s^{-4}$, which follows rigorously from analyticity and unitarity only. We discuss the possible validity of the above bounds in axiomatic field theory and show that our bounds also follow from alternative conditions which, unlike (a), have a chance of being true in field theory. It is also shown that the behavior $\langle n\rangle \sim s^a$ necessarily leads to an exponential behavior in s for $\mathrm{Max}_n|\sigma_n(s,\lambda)|$ for some complex λ whenever (a) holds. (auth)

14074 EIKONAL EXPANSION AS THE HIGH-ENERGY LIMIT OF THE BORN SERIES. Swift, A.R. (Department of Physics and Astronomy, University of Massachusetts, Amherst, Massachusetts 01002). Phys. Rev. D 9: No. 6, 1740-1749 (15 Mar 1974).

The Glauber version of the eikonal expansion in potential theory is shown to be the unique result of calculating the high-energy, fixed-momentum-transfer limit of the Born series. Correction terms are systematically calculated and agree with the form proposed by Wallace. These results are used to understand the fact that the Glauber eikonal is an accurate approximation to the exact scattering amplitude at all energies. (auth)

14075 THEORY OF CLUSTER APPROXIMATIONS. Rosenberg, L. (Department of Physics, New York University, New York, New York 10003). Phys. Rev. D 9: No. 6, 1789-1802 (15 Mar 1974).

Calculations of the scattering matrix for nonrelativistic multiparticle collision processes are often based on a decomposition of the system into interacting clusters, with a particular form assumed for the effective interaction among the clusters. This approach is formalized here by the definition of an exact effective interaction operator for the general multichannel scattering problem. While other formal definitions can be given, based, e.g., on Faddeev equations or on Feshbach projection-operator techniques, the approach described here is particularly well suited for the introduction of variational approximations. The variational property of the approximate effective potential can be maintained even when the bound-state wave functions of the subsystems are known only approximately. Furthermore, for sufficiently low scattering energies each trial function which enters into the calculation can be systematically improved using a rigorous subsidiary minimim principle of the Rayleigh-Ritz type. (auth)

14076 SEPARABILITY IN DIRECTLY INTERACTING RELATIVISTIC PARTICLE SYSTEMS. Foldy, L.L. (Physics Department, Case Western Reserve University, Cleveland, Ohio 44106); Krajcik, R.A. Phys. Rev. Lett. 32: No. 18, 1025-1028 (6 May 1974).

We present a representation of the Poincaré group corresponding to a directly interacting system of particles valid to order $1/c^2$ which satisfies the condition of separability of the interaction. (auth)

14077 s-DEPENDENCE, SIGN OF THE CUT, AND FACTORIZATION IN A t-CHANNEL PARTIAL-WAVE AMPLITUDE WITH REGGE CUTS. Desai, B.R. (Service de Physique Théorique, Centre d'Etudes Nucléaires de Saclay, BP no. 2, Gif-sur-Yvette, Saclay, France); Kaus, P.E.; Tsarev, V.A. Phys. Rev. D 9: No. 7, 1991-2004 (1 Apr 1974).

Using an effective-range-type expansion in the j plane for the N and D functions, the t-channel partial-wave amplitude A(j, t) (= N/D) is expressed as $[F_1+F_2(j-\alpha_c)+G_1(j-\alpha_c)^{1/2}]/[j-\alpha_0+\epsilon(j-\alpha_c)^{1/2}]$, where a square-root singularity is assumed for simplicity. For α_0 linear in t the following results are obtained: (I) The Regge poles ($=\alpha_s$) are complex below a certain t value. (II) The amplitude A(s, t) in the scattering region is of the form $a_+(s,t)s^{\alpha_+}+a_-(s,t)s^{\alpha_-}$, with $a_\pm(s,t)$ expressible as a sum of two terms. The first term is one-half the residue of the complex pole, whether the pole be on the physical or unphysical sheet, the second term is a series involving the product $(\alpha_s-\alpha_c)\ln s$. It is found by explicit calculation that if ϵ is small ($\simeq$0.1) then only one or two terms of the series are important up to quite high s ($\simeq$200 BeV^2). Only at asymptotic s will the series sum up to give the tip of the cut contribution, $s^{\alpha_c}/(\ln s)^{3/2}$. At presently available energies, therefore, the s dependence is largely given by s^{α_s}. The results remain unchanged if the pole is on the real axis ($\epsilon = 0$). (III) At the t value where the poles collide, the s dependence is of a typical double pole from $s^{\alpha}\ln s$. (IV) It is observed that the strength of the cut is manifested through $|F_2/F_1|$ and $|G_1/F_1|$ as well as through ϵ. (V) For small, fixed ϵ the F_2 term plays a crucial role in shifting the zeros in t of A(s, t) from their simple pole values. (VI) The sign of the cut is intimately connected with the phase of the complex residues for $t \leq 0$, the width of the t channel resonances, and with the question of determining the sheet on which the poles are located for $t \leq 0$. (VII) Finally, A(s, t) is in general not factorizable but can be written as a sum of (complex conjugate) factorized quantities. (auth)

14078 ON STANDING WAVE SOLUTIONS TO THE SCHRÖDINGER EQUATION. Kouri, D.J. (School of Chemical

Sciences, University of Illinois at Urbana–Champagne, Urbana, Illinois 61801); Levin, F.S. Ann. Phys. (N.Y.) 83: No. 2, 316-325 (Apr 1974).

The standing wave solution to the Schrödinger equation defined in terms of the standing wave Green's function for the full Hamiltonian is discussed. This solution is compared with the more usual standing wave solution. The former is shown to be one-half the sum of the usual ingoing and outgoing wave solutions obeying Lippmann–Schwinger equations. Partial wave elements of the two solutions as well as of the two reaction (K) matrices are found to be related by a simple normalization factor, viz. $\cos^2 \delta_l$, where δ_l is the lth partial wave phase shift. Thus, either of the two standing wave solutions can be used to obtain the correct K matrix element, $\tan \delta_l$, since in each case it is the asymptotic ratio of the irregular to the regular solution. (auth)

14079 ON STANDING WAVE SOLUTIONS TO THE INHOMOGENEOUS EQUATION FOR IDENTICAL PARTICLE SCATTERING. Kouri, D.J. (School of Chemical Sciences, University of Illinois at Urbana–Champagne, Urbana, Illinois 61801); Levin, F.S. Ann. Phys. (N.Y.) 83: No. 2, 326-339 (Apr 1974).

The standing wave solution to the inhomogeneous equation describing identical particle scattering is reexamined. Although the form of that solution is correct, its content is shown to be incorrect. A paradigm for constructing the correct solution, based on unitarity, is discussed, and the proper solution is then obtained. A comparison of different standing wave solutions with differing K operators is given. The results are shown to be an extension to the multichannel case of those derived in the preceding paper for the potential well case. (auth)

14080 REQUIREMENTS FOR SCATTERING SOLUTIONS AND THE CAUSAL GREEN'S FUNCTION OF THE BETHE-SALPETER EQUATION. Hormozdiari, I. (Physics Department, Pahlavi University, Shiraz, Iran); Huang, J.C. Phys. Rev. D 9: No. 8, 2285-2290 (15 Apr 1974).

We investigate the conditions necessary for the existence of scattering solutions to the Bethe–Salpeter equation. We work with the causal Green's function in both timelike and spacelike regions of $\chi - \chi'$. Our results indicate that high–momentum or small–relative–time limits must be taken. In the small–relative–time limit, suitable restrictions on the interaction $I(\chi)$ must also be considered. (auth)

14081 CORRESPONDENCE OF PARTIAL–WAVE AND IMPACT–PARAMETER REPRESENTATIONS. Wallace, S.J. (Lyman Laboratory of Physics, Harvard University, Cambridge, Massachusetts 02138). Phys. Rev. D 9: No. 2, 406-407 (15 Jan 1974).

An alternative but much simpler proof is given that a recently developed high–energy expansion accomplishes the mapping between the partial–wave amplitude and the Fourier–Bessel impact–parameter amplitude. The high–energy expansion is also shown to converge to the exact result for Coulomb scattering at all energies and scattering angles. A Regge pole in the partial–wave amplitude maps to a cut in the Fourier–Bessel impact–parameter amplitude, i.e., the existence of poles in the impact–parameter amplitude is dubious. (auth)

PHYSICS (LOW-TEMPERATURE)

Superfluidity

14082 SEMI-PHENOMENOLOGICAL THEORY OF TWO PHASE TRANSITIONS IN LIQUID ^{3}He BELOW 3 m°K. Amritkar, R. E.; Kumar, N. (Indian Inst. of Science, Bangalore). Lett. Nuovo Cim.; 10: No. 3, 81-84(18 May 1974).

A simple model Hamiltonian is proposed that seems to describe these phases fairly well in terms of the intrapair and the interpair spin-dependent interactions. In doing so, a cue was taken from the physical fact that the transition appears to involve the dynamics of the nuclear spins in an essential fashion, in the reciprocal space. (MHR)

14083 COMMENT ON THE PRESSURE DEPENDENCE OF PHONON-PHONON SCATTERING RATES IN He II. Jäckle, J. (Fachbereich Physik, Universität Konstanz, D 775 Konstanz, Germany); Kehr, K.W. Phys. Rev. A 9: No. 4, 1757-1759 (Apr 1974).

The pressure dependence of the parallel three-phonon process is investigated and the expected pressure dependence of the wide-angle phonon scattering rate is discussed. (auth)

14084 NMR STUDIES OF THE A PHASE OF LIQUID ^{3}He. Bozler, H.M.; Bernier, M.E.R.; Gully, W.J.; Richardson, R.C.; Lee, D.M. (Laboratory of Atomic and Solid State Physics and Materials Science Center, Cornell University, Ithaca, New York 14850). Phys. Rev. Lett. 32: No. 16, 875-879 (22 Apr 1974).

We report measurements of the transverse and longitudinal NMR spectra of liquid ^{3}He in low magnetic fields which support the axial-state model for the liquid in the A phase. A quite unexpected additional result found in this work is that the width of the shifted transverse resonance line becomes extremely broad at temperatures well below A. (auth)

14085 EVIDENCE FOR UPWARD PHONON DISPERSION IN LIQUID ^{4}He FROM THE ANGULAR SPREADING OF PHONON BEAMS. Mills, N.G.; Sherlock, R.A.; Wyatt, A.F.G. (Department of Physics, University of Nottingham, University Park, Nottingham NG7 2RD, England). Phys. Rev. Lett. 32: No. 18, 978-981 (6 May 1974).

Measurements have been made of the angular spreading of initially well-defined beams of phonons of energies $\hbar\omega/k_B \lesssim 12$ K in liquid ^{4}He at $T \sim 0.1$ K and at pressures between saturated vapor pressure and 24 bars. The spreading is consistent with three-phonon decay processes and the results strongly suggest that in the dispersion relation $\omega = cq(1-\gamma\hbar^2q^2)$ the constant γ is negative at $p \lesssim 17$ bars and positive at higher pressures. (auth)

14086 EXPERIMENTAL DETERMINATION OF THE VISCOSITY AND DENSITY OF THE NORMAL COMPONENT OF SUPERFLUID ^{3}He AT THE MELTING CURVE. Alvesalo, T.A.; Collan, H.K.; Loponen, M.T.; Veuro, M.C. (Low Temperature Laboratory, Helsinki University of Technology, SF-02150 Otaniemi, Finland). Phys. Rev. Lett. 32: No. 18, 981-985 (6 May 1974).

The viscosity and the density of the normal component of liquid ^{3}He in the A and B phases have been determined at the melting curve with a vibrating-wire viscometer. The results show that resistive flow of the liquid is accompanied by a flow of zero viscosity. The data thus prove superfluidity both in the A and in the B phase. (auth)

14087 EXCITATION SPECTRUM AND THERMODYNAMIC PROPERTIES OF LIQUID FILMS IN CYLINDRICAL PORES. Cole, M.W. (Department of Physics, University of Washington, Seattle, Washington 98195); Saam, W.F. Phys. Rev. Lett. 32: No. 18, 985-988 (6 May 1974).

We examine the dynamic and thermodynamic properties of adsorbed liquid films in cylindrical cavities. We find a dynamical stability limit for the thickness of films adsorbed uniformly on the walls. This limit is shown to coincide with a thermodynamic stability limit which depends on both substrate and capillary forces. The Kelvin equation describing capillary condensation is generalized to include the substrate interaction. The low-temperature properties of the films are calculated. (auth)

14088 PRESSURE SHIFTS AND QUENCHING OF ATOMIC AND MOLECULAR STATES PRODUCED IN ELECTRON-BOMBARDED LIQUID HELIUM. Soley, F.J.; Fitzsimmons, W.A. (University of Wisconsin, Madison, Wisconsin 53706). Phys. Rev. Lett. 32: No. 18, 988-991 (6 May 1974).

The optical absorption and emission spectra of electron-bombarded liquid helium has been studied as a function of pressure between the saturated vapor pressure and 25 atm. The transitions of He^* and He_2^* in the liquid shift toward the blue with increasing pressure. The observed line profile and pressure shift of the $He(2^3P) \rightarrow He(2^3S)$ atomic absorption line are in good agreement with recent static line broadening calculations. We also report a strong pressure-dependent quenching of the excited atomic and molecular states in the liquid. (auth)

14089 SURFACE EXCITATIONS AND SURFACE TENSION OF SUPERFLUID He^4. Edwards, D.O.; Eckardt, J.R.; Gasparini, F.M. (Department of Physics, The Ohio State University, Columbus, Ohio 43210). Phys. Rev. A 9: No. 5, 2070-2077 (May 1974).

The Atkins theory of the temperature dependence of the surface tension α in superfluid He^4 has been improved by including the effects of compressibility, phonon dispersion, and Gibb's "surface adsorption" or "surface mass" in the calculation of the spectrum of the surface excitations or "ripplons." The theoretical ripplon spectrum is found to have a minimum close to the roton minimum in the empirical phonon spectrum. The results of the theory, which should be accurate up to a temperature of ~1.3 K, are presented in terms of the ripplon and phonon contributions to the surface entropy ($-d\alpha/dT$). The ripplon spectrum and the surface entropy are found to depend on two phenomenological parameters: a length δ which is the surface mass per unit area divided by the density, and an area a which is the derivative of δ with respect to the curvature of the surface. In principle, both δ and a can be obtained from static measurements on curved surfaces. The theory is compared to new measurements of the surface entropy near 1 K and, assuming that δ is small, a is found to be about 1.5 $Å^2$. (auth)

14090 SOME NEW FOURTH-SOUND INVESTIGATIONS OF FINITE-SIZE EFFECTS IN He II USING A POROUS-GLASS MATRIX. Gregory, S.; Lim, C.C. (University of Waterloo, Department of Physics, Waterloo, Ontario, Canada). Phys. Rev. A 9: No. 5, 2252-2254 (May 1974).

The superfluid fraction ρ_s/ρ of He II in Vycor porous glass has been studied in the range (approximately) 1.6-2.0 K using fourth sound. There is a qualitative difference in the temperature dependence of ρ_s/ρ between this work and that obtaining for He II in comparable packed powders. (auth)

14091 ANALYSIS OF EXPERIMENTAL DATA ON NEUTRON SCATTERING FROM SUPERFLUID HELIUM AT LARGE MOMENTUM TRANSFERS. Rodriguez, L.J.; Gersch, H.A. (School of Physics, Georgia Institute of Technology, Atlanta, Georgia 30332); Mook, H.A. Phys. Rev. A 9: No. 5, 2085-2098 (May 1974).

In previous work an expression was developed which partially incorporates the effect of final-state interactions on thermal-neutron scattering from a many-body system. This expression is evaluated for a liquid He^4 target at momentum transfers of 14.3 and 28.6 $Å^{-1}$. The experimental results of Mook, Scherm, and Wilkinson for the scattering of neutrons from liquid helium are analyzed in terms of (a) a modified impulse approximation which includes final-state corrections only in the condensate contribution to the scattering and (b) an approximation which includes final-state effects on both condensate and noncondensate contributions to the scattering. These calculations substantiate a previous empirical assessment of the condensate portion of the scattering [(2.4 ± 1) %] and suggest that certain barely discernible features of the experimental scattering are real structures in the condensate contribution attributable to the structure of the liquid and the interaction potential of the helium atoms. Other helium properties deduced from the data at 1.2 and 4.2°K are single-particle momentum distribution, one-particle density matrix, and mean kinetic energy of the helium atoms. These quantities are compared with predictions from existing Monte Carlo numerical studies of the ground state of He^4. (auth)

14092 CRITICAL BEHAVIOR OF ION MOBILITIES NEAR THE SUPERFLUID TRANSITION. Goodstein, D. (Laboratori Nazionali del Comitato Nazionale per l'Energia Nucleare, Frascati, Roma, Italy); Savoia, A.; Scaramuzzi, F. Phys. Rev. A 9: No. 5, 2151-2166 (May 1974).

Measurements are reported of the mobilities of helium ions in superfluid helium very close to the λ transition. The mobilities of both positive and negative ions appear to be singular in the sense of having infinite slope at the transition. The measurements are made by a new differential technique, based on the space-charge-limited method, which makes possible a sensitivity to changes in mobility of the order of parts in 10^4. This allows mobility measurements into the range $|\epsilon| < 10^{-4}$, where $\epsilon = (T/T_\lambda)-1$. Most of the reported measurements are taken along isotherms which cross the λ line at elevated pressures, although a series at saturated vapor pressure is also reported. Means of transforming the data between various thermodynamic paths are discussed. Uncertainty as to which thermodynamic path should be considered fundamental together with experimental problems in the technique at this stage in its development make quantitative assessment of the singularity difficult. However, if we assume a limiting form $(\mu-\mu_\lambda)/\mu_\lambda \sim (-\epsilon)^{\rho'}$, where μ is the mobility and μ_λ its value at the transition, we find for the exponent $\rho' = 0.94 \pm 0.02$. (auth)

14093 COMMENT ON SOME PROPOSED MECHANISMS FOR ATTENUATION OF THIRD SOUND. Cole, M.W. (University of Washington, Seattle, Washington 98195); Goodstein, D.L. Phys. Rev. A 9: No. 6, 2806-2807 (June 1974).

Two explanations have been proposed for an apparent discrepancy between theoretical prediction and experimental measurement of third-sound attenuation. One of these proposes a new "macroscopic quantum uncertainty principle," and the other proceeds via nonlinear, anharmonic effects due to zero-point fluctuations. We argue that neither suggestion is acceptable. (auth)

14094 SMALL-ANGLE SCATTERING OF PHONONS AND SOUND PROPAGATION IN LIQUID HELIUM BELOW 0.6 K. Wehner, R.K. (Laboratories RCA Ltd., Zurich, Switzerland). Phys. Rev. A 9: No. 6, 2625-2630 (June 1974).

The small-angle scattering of phonons with anomalous dispersion has been studied by evaluating the three-phonon collision operator. The characteristic scattering angle is used as a parameter for a new interpretation of sound propagation. The results indicate that the relationship most commonly used for anomalous dispersion is incompatible with the sound-absorption experiments at about 0.1 K. (auth)

14095 LONG-WAVELENGTH EXCITATIONS IN A BOSE GAS AT ZERO TEMPERATURE. Wong, V.K. (Department of Physics, University of Michigan, Ann Arbor, Michigan 48104); Gould, H. Ann. Phys. (N.Y.) 83: No. 2, 252-302 (Apr 1974).

The long-wavelength excitations in a simple model of a dilute Bose gas at zero temperature are investigated from a purely microscopic viewpoint. The role of the interaction and the effects of the condensate are emphasized in a dielectric formulation, in which the response functions are expressed in terms of regular functions that do not involve an isolated single-interaction line nor an isolated single-particle line. Local number conservation is incorporated into the formulation by the generalized Ward identities, which are used to express the regular functions involving the density in terms of regular functions involving the longitudinal current. A perturbation expansion is then developed for the regular functions, producing to a given order in the perturbation expansion an elementary excitation spectrum without a gap and simultaneously response functions that obey local number conservation and related sum rules. Explicit results to the first order beyond the Bogoliubov approximation in a simple one-parameter model are obtained for the elementary excitation spectrum ω_k, the dynamic structure function $S(k,\omega)$, the associated structure functions $S_m(k)$, and the one-particle spectral function $A(k,\omega)$, as functions of the wavevector k and frequency ω. These results display the sharing of the gapless spectrum ω_k by the various response functions and are used to confirm that the sum rules of interest are satisfied. It is shown that ω_k and some of the $S_m(k)$ are not analytic functions of k in the long wavelength limit. The dynamic structure function $S(k,\omega)$ can be conveniently separated into three parts: a one-phonon term which exhausts the f sum rule, a backflow term, and a background term. The backflow contribution to the static structure function $S_0(k)$ leads to the breakdown of the one-phonon Feynman relation at order k^3. Both $S(k,\omega)$ and $A(k,\omega)$ display broad backgrounds because of two-phonon excitations. Simple arguments are given to indicate that some of the qualitative features found for various physical quantities in the first-order model calculation might also be found in superfluid helium. (auth)

14096 LANDAU-GINSBURG EQUATIONS FOR AN ANISOTROPIC SUPERFLUID. Ambegaokar, V.; deGennes, P.G.; Rainer, D. (Cornell University, Ithaca, New York 14850). Phys. Rev. A 9: No. 6, 2676-2685 (June 1974).

A discussion of an anisotropic (p state) Fermi superfluid with a spatially varying order parameter is presented. We restrict ourself to the Landau-Ginzburg region and consider spatial variations governed by the linear gap equation. The kernel of the linearized gap equation is shown to be related to a current-current correlation function of quasiparticles in the normal state. This relation permits the calculation of the two coherence lengths ξ_L and ξ_T defined earlier in the framework of a phenomenological Landau-Ginzburg theory, and a discussion of boundary conditions for the order parameter at interfaces. A significant anisotropy in the coherence lengths is found ($\xi_L = \sqrt{3}\,\xi_T$), which reflects itself in the nature of the supercurrents. The boundary conditions at specularly and diffusely reflecting surfaces lead us to expect that the vector $\vec{l}$, which describes the orbital angular momentum of a Cooper pair in an "axial" state, is anchored normal to the walls. Some consequences of these results on various experimental problems (fourth sound, monodomain production, Josephson couplings, behavior in thin capillaries) are briefly discussed. (auth)

14097 SURFACE SECOND SOUND IN SUPERFLUID HELIUM. Shen, S. Y. Columbus, OH; Ohio State Univ. (1973). 186p. University Microfilms Order No. 74-11,047.

Thesis (Ph. D.).

The discovery of surface second sound and some measurements of its velocity in ^{3}He adsorbed on the surface of superfluid helium are described. The surface second sound velocity and the surface tension were measured simultaneously in the temperature range of 20 to 300 mK for two samples of different ^{3}He concentration. The sound velocity was measured by a time of flight technique and the surface tension by a capillary rise method. In the latter, the temperature variation of the capillary rise between the plates of a parallel plate capacitor was balanced by an electric field, with a resolution of a hundredth of a percent of the surface tension. The experimental results are consistent with a model in which the adsorbed ^{3}He is treated as a weakly interacting two-dimensional gas of surface quasiparticles. The binding energy in the surface is determined to be 2.26 ± 0.04 K larger than that in the bulk liquid and the interaction between the ^{3}He quasiparticles is found to be predominantly repulsive. (Diss. Abstr. Int., B)

14098 MEASUREMENTS OF HELIUM II FLOW THROUGH SMALL PORES. Sabo, B. B. Minneapolis; Univ. of Minnesota (1973). University Microfilms.

Thesis (Ph. D.).

The measurement, by a new and convenient method, of variations of the average superfluid density of liquid helium in small pores of well-defined geometry, is reported. In addition, the onset of dissipation of superfluid flow in these pores was investigated. The temperature range of the measurements was from about 1.1 K to within 12 mK of the lambda point at 2.1632 K (at one atmosphere). Three different superleaks were studied, a single 10 μm diameter orifice in a nickel substrate 38 μm thick, and 0.1 μm and 0.5 μm Nucleopore membranes 11 μm and 12 μm thick. The latter contained numerous pores of uniform size and shape, nominally 0.1 μm and 0.5 μm in diameter, respectively. For each superleak we also observed an extrinsic regime in which the superfluid critical velocity is temperature-independent, but pore-size dependent, and is in good quantitative agreement with the expression derived by W. Zimmerman, Jr. Finally, by the use of a pressure detection system with a fast response time we have been able to observe an unexpected and rapid energy dissipation in a single orifice. (MHR)

14099 EXPERIMENTAL PROPERTIES OF NEUTRAL EXCITATIONS PRODUCED IN ELECTRON-BOMBARDED SUPERFLUID HELIUM AT TEMPERATURES BETWEEN 0.30°K AND 0.70°K. Mitchell, R. P. Eugene, OR; Univ. of Oregon (1973). 177p. University Microfilms Order No. 74-6873.

Thesis (Ph. D.).

The discovery and experimental properties of neutral excitations generated in electron bombarded superfluid helium are reported. The excitation current is present only for temperatures below 0.70°K, and only when a strong electric field is placed in the ionization region; the field direction being such to drive positive ions from the ionization region toward the liquid surface. No excitation flux is so generated on reversing the field in the source region. A model for the neutral excitation is presented which satisfactorily explains the experimental results. The model proposes that the neutral excitation consists of a metastable atom or molecule trapped on a neutral vortex ring which under suitable conditions leaves the source ionization region and travels to the liquid surface. The vorticity which accumulates at the liquid surface provides an effective trapping matrix for the metastables upon which they are trapped and random walk until mutually annihilating. The products of the annihilation process are ground state helium atoms and energetic free charge. The role of neutral vortex rings and electron tunneling into the vapor are also examined in this connection. Properties in the source region as well as the temperature characteristics of the excitation find satisfactory explanations in this model. (MHR)

14100 HELIUM II FILM TRANSFER RATES FOR SOLID-ARGON BEAKERS. Milbrodt, T. O. Ann Arbor, MI; Michigan State University (1973). 66p. University Microfilms Order No. 74-6092.

Thesis (Ph. D.).

Helium II film transfer rates have been measured for filling and for emptying beakers of solid argon. Liquid argon was frozen slowly in a mold which was later removed, leaving free-standing, transparent solid-argon beakers. The beakers used were of 3 mm i.e., 5 mm OD, and 3.5 cm in height. Experiments were carried out in the temperature range 1.45–2.0 K. The dependence of the transfer rate σ (cm^3/sec-cm of circumference) on the difference between the inner and outer helium levels Z, height of the beaker lip above the level of the liquid source H, and temperature, were studied. The transfer rates were lower than those observed with glass beakers, in agreement with theory. For beaker fillings with a level difference of 1 mm and at a temperature of 1.66 K, the measured transfer rates may be described by the relation $\sigma = 4.8\ H^{-0.21} \times 10^{-5}$ cm^2/sec, where H is in cm. (Diss. Abstr. Int., B)

14101 VORTEX RING CREATION PROCESS IN He II. Titus, J. A. Gainesville, FL; University of Florida (1973). 87p. University Microfilm Order No. 74-9566.

Thesis (Ph. D.).

Measurements of vortex-ring current created by ions in both dc and pulsed electric fields have been made in the temperature range of 0.55 to 0.70°K. Measurements of current as a function of electric field in the dc case show that vortex rings are created over a range of electric fields, as suggested by the nucleation theory of Donnelly and Roberts. However, the agreement of the measured vortex-ring currents with those predicted by the nucleation theory of Donnelly and Roberts is only fair. Vortex-ring currents were also measured in pulsed electric fields of duration ranging from 1.0 μsec to 120 μsec. The results show that the number of vortex rings created is an exponential function of time, as predicted by the nucleation theory of Donnelly and Roberts. This agreement with the theory enables the identification and measurement of vortex-ring nucleation frequencies. Nucleation frequencies ranging from 1.4×10^3 to 1.4×10^5 $sec.^{-1}$ have been measured in electric fields from 19 to 128 V/cm. However, the velocity dependence of the measured nucleation frequencies is only fair. The poor agreement between theory and experiment may be due to problems in converting the electric fields to ion drift velocities. (Diss. Abstr. Int., B)

14102 INVESTIGATION OF THE THICKNESS AND CRITICAL VELOCITY OF A MOVING UNSATURATED SUPERFLUID FILM USING DOPPLER SHIFTED THIRD SOUND. Telschow, K. L. Los Angeles; University of California (1973). 111p. University Microfilms Order No. 74-3987.

Thesis (Ph. D.).

The velocity of third sound waves on a moving unsaturated superfluid film has been measured by the time of flight technique. The film was propelled by a heater placed at one end of a glass substrate. Two smoothly connected cylindrical glass sections, with diameters in a ratio of approximately 4 : 1, formed the substrate and allowed simultaneous measurements at two different film flow velocities. The Doppler shift was determined to be $C_3^+ - C_3^-/2 = ((\rho_s)/\rho)\ V_s$ where C_3^+ is the velocity of the wave parallel and antiparallel to the film flow velocity V_s and $\langle\rho_s\rangle/\rho$ is the reduced superfluid fraction in the unsaturated film. The thickness of the moving film was probed by the average of the two Doppler shifted velocities. To within experimental precision, no changes in the average velocity with the film flow velocity were observed. The thickness, therefore, is constant for the moving unsaturated film in agreement with previous experiments done on saturated films. This result presents a fundamental problem to the interpretation of the theory of liquid helium. Several possible resolutions to this paradoxical behavior are presented. The critical flow velocity was measured by the abrupt change in the Doppler shift as the film was accelerated by increasing the heater power. This experiment measures the flow velocity more directly than previous experiments through the Doppler shift. The critical point was always very distinct in contrast to the behavior of temperature gradients within the film. At all temperatures investigated, the critical velocity rises rapidly from zero at the onset thickness to a maximum value and then decreases more gently as the thickness of the film increases. The maximum values are typically 100 to 200 cm/sec and increase with decreasing temperature. Qualitative agreement is observed between critical velocities reported here and a previous experiment with Doppler shift measurements on saturated films. (Diss. Abstr. Int., B)

14103 DISK OSCILLATIONS IN A ROTATED SOLUTION OF ^{3}He–^{4}He. Tsakadze, J. D. (Inst. of Physics, Tbilisi). Soobshch. Akad. Nauk Gruz. SSR; 74: No. 2, 309-312(May 1974). (In Russian).

Elastic-plastic properties of superfluid solutions of ^{3}He–^{4}He of different concentrations have been studied. It is shown that with an increase of concentration of ^{3}He in ^{4}He the maximum on the curve of the dependence of damping of disk oscillations on the velocity of rotation decreases and is displaced towards high velocities of rotation. The observed phenomena agree well with the assumption of an increase of the vortex core in the solution due to adsorption of a light isotope on the vortex core. (auth)

14104 SOUND IN SUPERFLUID LIQUIDS. Esel'son, B. N.; Kaganov, M. I.; Rudavskii, E. Ya.; Serbin, I. A. (Physical-Technical Inst. of Low Temperatures, Kharkov). Usp. Fiz. Nauk; 112: No. 4, 591-636(Apr 1974). (In Russian).

The existence of two sounds of different nature in superfluid liquids is one of the most known and studied characteristics of He. Since the discovery of the second sound a vast amount of experimental and theoretical materials has accumulated on the study of the wave processes in He. In the last 10 years interest in this problem has intensified, probably because of the discovery of third and fourth sounds (oscillations with the slowed down normal components of the liquid) and probably because of the possibility of studying the ultrashort sound waves from the scattering of neutrons and light quanta. The basic theoretical studies and experimental results on the propagation of sound waves of different nature in superfluid liquids (^{4}He and ^{3}He–^{4}He solutions) were reviewed. Special attention is given not only to the qualitative but to the quantitative comparison of experimental results with theory. The bibliography is as complete as possible. The propagation of sound near the λ point, the passage of waves through the boundary of two liquids or a liquid and vapor, and the propagation of sound waves of large amplitude are not considered in the review. (tr-auth)

Superconductivity

Refer also to abstracts 13073, 13189–13192, 13241, 13257, 13864, and 14411.

14105 (LA-UR-74-737) SUPERCONDUCTING MAGNETIC ENERGY STORAGE. Laquer, H. L. (Los Alamos Scientific Lab., N. Mex. (USA)). 1974. Contract W-7405-eng-36. 22p. (CONF-740509-7). Dep. NTIS $4.25.

From fifth international cryogenic engineering conference; Kyoto, Japan (7 May 1974).

After a brief review of the reasons for and forms of secondary energy storage and of the elements and history of inductive or magnetic storage, four distinct areas are discussed in which superconducting magnetic energy storage can be applied. Differences in energy transfer times place different requirements on the storage coil, on the switch or transfer element and on the energy losses in the superconductor. Designs and experiments in one of these areas with 2 to 300 kJ units, and analysis and plans for an installation that is to provide 250 MJ of plasma compression energy for the theta-pinch controlled thermonuclear fusion test reactor are discussed. Those elements of inductive storage that need further development before a theta-pinch fusion reactor can become economically competitive are mentioned. Size and costs of the energy storage components of these systems are compared with similar and with larger inductive storage systems that are to interact reversibly with electric utility networks. (auth)

14106 ELECTRON TUNNELING AND SUPERCONDUCTIVITY. Giaever, I. (General Electric Research and Development Center, Schenectady, NY). Science: 183: No. 4131, 1253-1258(29 Mar 1974).

The work which led to the Nobel prize is described in detail. Autobiographical details are included. (MHR)

14107 DIAMAGNETISM OF SUPERCONDUCTING ALLOYS ABOVE T_c. Kiknadze, L. V.; Cheishvili, O. D. (Inst. of Physics, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR; 74: No. 1, 73-76(Apr 1974). (In Russian).

The dependence of diamagnetic susceptibility of very impure superconductors on the magnetic field above the temperature of the superconducting transition is considered on the basis of the generalized equation of Ginzburg–Landau. It is shown that the quantity $M/e^{\frac{1}{2}}\ T_c H^{\frac{1}{2}}$ decreases with an increasing H/H_{c_2} (O) when $T = T_c$ for massive samples. The case of thin films is also considered. (auth)

14108 LOSSES IN SINGLE-CORE SUPERCONDUCTING COMPOSITE CONDUCTORS. Shiiki, K.; Aihara, K.; Kudo, M.; Irie, F. (Hitachi Ltd., Tokyo). Cryogenics; 14: No. 6, 343-345(Jun 1974).

The loss occurring in single-core composite conductors from the frequency dependence of the loss has been studied. Samples were copperclad wires and bare superconducting wires of Nb–62.5-Ti–2.5Zr superconducting ternary alloy. The composites consisted of about 250 μm diameter superconducting wire with a 34 to 126 μm thick copper layer. The ac losses were measured by a boil-off method at 4.2K in the frequency range 20 to 500 Hz for sinusoidal currents up to 100 A rms. A linear relationship was found between the loss per cycle and the frequency. In bare superconducting wires the loss per cycle is independent of frequency and is proportional to the peak magnetic field. The ac losses in the single-core superconducting composite conductor can be represented as the sum of the hysteresis loss in the superconductor and the eddy current loss in the copper layer. (UK)

14109 ANALOG BETWEEN SMECTIC A LIQUID CRYSTALS AND SUPERCONDUCTORS. Halperin, B. I.; Lubensky, T. C. (Bell Telephone Labs., Murray Hill, NJ). Solid State Commun.; 14: No. 10, 997-1001(15 May 1974).

The analogy between a smectic A liquid crystal and a superconductor is made closer by a gauge transformation on the smectic

system. Within the context of the Wilson–Fisher recursion relations, it is shown that the critical properties of the two systems are the same, and that therefore the phase transition from smectic A to nematic will always be at least weakly first order. (auth)

14110 SINGLE-PARTICLE STATES, KOHN ANOMALY, AND PAIRING FLUCTUATIONS IN ONE DIMENSION. Luther, A. (Lyman Laboratory, Harvard University, Cambridge, Massachusetts 02138); Peschel, I. Phys. Rev. B 9: No. 7, 2911-2919 (1 Apr 1974).

We compute the single-particle spectral density, susceptibility near the Kohn anomaly, and pair propagator for a one-dimensional interacting-electron gas. With an attractive interaction, the pair propagator is divergent in the zero-temperature limit and the Kohn singularity is removed. For repulsive interactions, the Kohn singularity is stronger than the free-particle case and the pair propagator is finite. The low-temperature behavior of the interacting system is not consistent with the usual Ginzburg-Landau functional because the frequency, temperature, and momentum dependences are characterized by the power-law behavior with the exponent dependent on the interaction strength. Similarly, the energy dependence of the single-particle spectral density obeys a power law whose exponent depends on the interaction and exhibits no quasiparticle character. Our calculations are exact for the Luttinger or Tomonaga model of the one-dimensional interacting system. (auth)

14111 LANDAU DOMAIN STRUCTURE. I. THEORY. Krempasky, J.J.; Farrell, D.E. (Department of Physics, Case Western Reserve University, Cleveland, Ohio 44106). Phys. Rev. B 9: No. 7, 2894-2901 (1 Apr 1974).

A new treatment is presented for the Landau domain structure that is realized when a magnetic field less than H_c is applied at a small angle to the large faces of a flat plate of a type-I superconductor. We work within the established framework of the Landau-Sharvin theory but attempt to take into account the nonlinear aspect of the magnetic interaction energy. The result is a new expression for the domain periodicity as a function of the fraction of the sample surface in the normal state, both of which quantities are direct experiment observables. Recent experimental work lends support to our result. (auth)

14112 LANDAU DOMAIN STRUCTURE. II. EXPERIMENT. Chien, M.K.; Farrell, D.E. (Department of Physics, Case Western Reserve University, Cleveland, Ohio 44106). Phys. Rev. B 9: No. 7, 2902-2910 (1 Apr 1974).

The Sharvin-Landau double-point-contact technique has been used to make an extensive study of the spatial periodicity a of the Landau domain structure in the dynamic intermediate state of superconducting aluminum. The samples were thin flat plates with the magnetic field applied at a small angle to the large sample faces. An ancillary field was utilized in order to improve the regularity of the moving structure. Highly regular motion was achieved over a wide range of C_N*, the fraction of the sample surface in the normal state. The dependence of a upon C_N* was found to be in good agreement with a modified Landau-Sharvin theory. (auth)

14113 PRECURSOR DIAMAGNETISM IN LAYERED AND ISOTROPIC SUPERCONDUCTORS. Gerhardts, R.R. (Department of Applied Physics, Stanford University, Stanford, California 94305). Phys. Rev. B 9: No. 7, 2945-2962 (1 Apr 1974).

The theory of diamagnetic fluctuations in a system of Josephson-coupled superconducting layers is studied using the approach of Kurkijärvi, Ambegaokar, and Eilenberger, but with a modified treatment of finite frequency fluctuations proposed by Maki and Takayama. Both temperature and field dependence of the fluctuation-induced magnetization above T_c are discussed. The results are extended to the limit of isotropic superconductors, where they are generally in good agreement with the experimental results of Gollub, Beasley, and Tinkham, for both clean and dirty superconductors. For weakly coupled layers, the temperature dependence of the magnetization for fixed field changes from a $[T-T_c(B)]^{1/2}$ behavior near the phase transition, typical of three-dimensional superconductors, to a $[T-T_c(B)]^{-1}$ behavior of two-dimensional character at higher temperatures, as predicted by Lawrence and Doniach. Similarly, the field dependence at T_c changes from a $\sqrt{B}$ dependence to a relatively field-independent behavior at higher fields. With increasing layer coupling, these changes take place at higher temperatures and fields, respectively, but they are masked by effects which suppress fluctuations at high fields and temperatures. The numerical results are consistent with the layer-compound data of Prober, Beasley, and Schwall, but they show that these compounds behave much more like three-dimensional than like two-dimensional systems, in spite of the apparent Curie-Weiss-like temperature dependence of the susceptibility. (auth)

14114 ABSORPTION OF LONGITUDINAL ULTRASOUND BY SUPERCONDUCTING INDIUM AND DILUTE ALLOYS OF TIN IN INDIUM. Binnie, D.E.; Reed, R.W.; Brickwedde, F.G. (Department of Physics, The Pennsylvania State University, University Park, Pennsylvania 16802). Phys. Rev. B 9: No. 7, 2936-2944 (1 Apr 1974).

Measurements were made of the absorption of sound (20–180 MHz) in pure In and alloys of 0.01, 0.03, and 0.09-at.% Sn in In, in the superconducting and normal states, between 1 and 4.2 K. When the absorption data were handled by the usual method, i.e., by using only experimental data between $1\ K < T < 0.85T_c$ and making Δ_0 and $\alpha'_n(1\ K)$ adjustable parameters to obtain the best fit of the BCS Δ (T) function to the experimental data, the Δ_0's obtained for pure In were in agreement with the Δ_0's for In determined by other observers using the ultrasonic technique. But all of these ultrasonic values for Δ_0 are low relative to Δ_0's determined by other experimental techniques. Extrapolating to 0 K, Δ (T)'s calculated from the BCS relation, $\alpha'_s/\alpha'_n = 2f(\Delta/T)$, yielded $\Delta_0 = 1.85kT_c$ in agreement with Δ_0's determined by techniques other than ultrasonic, but the calculated Δ (T)'s deviated considerably from the BCS function for Δ (T). The departure from the BCS equation of our calculated Δ (T)'s, and the disagreement of the ultrasonic Δ_0's with other Δ_0's are attributed to sonic absorption by line dislocations set in vibration by the sound and damped by the conduction electrons. It was established experimentally that for our specimens and apparatus, the dislocation attenuation was independent of the sonic amplitude. Our experimental $\alpha'_s(T)$, $\alpha'_n(T)$ data were analyzed using the theory of Mason for attenuation by dislocations independent of the sonic amplitude and the BCS theory. The results of this analysis are consistent with both theories and with data obtained using other than ultrasonic techniques. (auth)

14115 CALCULATION OF THE TEMPERATURE AND THE PURITY DEPENDENCE OF SOUND ATTENUATION IN SUPERCONDUCTING Nb. Sung, C.C. (Department of Physics, The University of Alabama in Huntsville, Huntsville, Alabama 35807); Lacy, L.L. Phys. Rev. B 9: No. 7, 2929-2935 (1 Apr 1974).

Recent experimental results on the sound attenuation, α_s, in the superconducting state of high-purity Nb are studied. By including the electron-phonon interaction in the BCS theory according to Eliashberg, as suggested by Carsey, Kegiwada, Levy, and Maki, we show that α_s/α_n decreases much faster than that limited by impurity scattering, where α_n is the sound attenuation in the normal state. The results deviate from the experimental data by approximately 40%, which is a substantial improvement over the impurity-limited BCS theory. If an energy gap is used to fit the data, it is found that the empirical value deviates from the BCS energy gap by 25%. In order to obtain the correct temperature dependence of α_n in comparison with experimental data, we have neglected the vertex correction in our calculation. In addition to the one-band model, we also examine the two-band model. Our results indicate that there is little difference between these two models for temperatures near the transition temperature; however, the two-band model predicts a smaller α_s in the lower-temperature region, in better agreement with the experimental data. (auth)

14116 TEMPERATURE DEPENDENCE OF H_{c3}/H_{c2} IN PURE VANADIUM. Boykin, J.C., Jr.; Bergeron, C.J., Jr. (Department of Physics, Louisiana State University at New Orleans, New Orleans, Louisiana 70122). Phys. Rev. B 9: No. 5, 2084-2089 (1 Mar 1974).

The ratio of the surface-nucleation field to the bulk superconducting critical field, H_{c3}/H_{c2}, has been measured over the reduced temperature range $0.2 < t < 0.92$ ($t = T/T_c$) in high-purity vanadium. It is found that the asymptotic value of the ratio at the low-temperature end of the range is 1.77 and as $t \to 1$, H_{c3}/H_{c2} also approaches 1 rather steeply. The experimental results are explained by considering the surface interaction potential to be slightly depressed as compared to the bulk interaction potential as suggested by Hu. This picture requires a modified boundary condition from that used in de Gennes's original calculation of a constant H_{c3}/H_{c2} ratio. We have determined that a reduction in the interaction potential of 0.9% is needed over a distance of $1.2\xi_0$ to explain the temperature dependence of H_{c3}/H_{c2}. A few possibilities as to the cause of this phenomenon are discussed. (auth)

14117 JOSEPHSON TUNNEL EFFECT AND THE ORDER PARAMETER OF SUPERCONDUCTING ALLOYS CONTAINING PARAMAGNETIC IMPURITIES WITH LOCAL STATES WITHIN THE GAP. Lo, S.C.; Singh Nagi, A.D. (Physics Department, University of Waterloo, Ontario, Canada). Phys. Rev. B 9: No. 5, 2090-2096 (1 Mar 1974)

Using the Green's function given by Shiba or Rusinov we have calculated some properties of a superconducting alloy containing paramagnetic impurities and having local states within the gap. These properties are (i) for a fixed impurity concentration p and for different values of ϵ_0 (the normalized position of a local state with a single impurity), the temperature dependence of the normalized order parameter δ (p, t) and the normalized maximum dc Josephson current i(p, t); (ii) for $\epsilon_0 = 0.6$ and $\epsilon_0 = 1.0$, and for different values of p, the temperature dependence of δ (p, t) and i(p, t); (iii) for $\epsilon_0 = 0.6$ and $\epsilon_0 = 1.0$, and for different fixed temperatures, the impurity concentration dependence of δ (p, t) and i(p, t). Our main results are (i) the impurity-concentration dependence of the normalized transition

temperature t_c of the alloy is the same both in the Shiba–Rusinov model ($\epsilon_0 = 0.6$) and the Abrikosov–Gorkov model ($\epsilon_0 = 1.0$); (ii) for a fixed value of the impurity concentration, and for temperatures low as compared to t_c, the differences between the values of i(p, t) [and also of δ (p, t)] in the two models are significantly different; (iii) for a fixed temperature, the above noted difference becomes greater as the impurity concentration is increased. (auth)

14118 STRONG-COUPLING EFFECTS IN THE TEMPERATURE DEPENDENCE OF κ_2(T). Rainer, D. (Laboratory of Atomic and Solid State Physics, Cornell University, Ithaca, New York 14850); Usadel, K.D. Phys. Rev. B 9: No. 5, 2409-2411 (1 Mar 1974).

A calculation of κ_2(T) in dirty strong-coupling superconductors is presented. It is shown that strong-coupling effects lead to an enhanced temperature dependence of κ_2(T). (auth)

14119 STABILITY OF SUPERCURRENTS IN CYLINDRICAL FILMS OF TIN. II. SINGLE-CRYSTAL SUBSTRATES. Meissner, H. (Department of Physics and Cryogenics Center, Stevens Institute of Technology, Hoboken, New Jersey 07030). Phys. Rev. B 9: No. 5, 2399-2401 (1 Mar 1974).

The previous measurements of Phillips and Meissner (which used Pyrex substrates) have been repeated using single-crystal quartz tubes as substrates. Differences in the results are rather minor, indicating that the observed phonomena are indicative of the superconductor rather than the substrate. (auth)

14120 RETARDED DISPERSION FORCES BETWEEN CONDUCTING SPHERES. Feinberg, G. (Department of Physics, Rockefeller University, New York, New York 10021). Phys. Rev. B 9: No. 6, 2490-2496 (15 Mar 1974).

The retarded dispersion forces between conducting spheres are calculated. It is shown that for perfect conductors, the contribution of magnetic dipole terms and higher-multipole terms are important, amounting to about 50% of the force asymptotically, and an even greater percentage at shorter distances. It is argued that ordinary conducting and superconducting spheres will behave as perfect conductors insofar as retarded dispersion forces are concerned, provided that the radius of the spheres is greater than about 10^{-4} cm for superconductors, and provided that the separation is less then 10^2a for ordinary conductors. Some comments on the measurability of these forces are presented. (auth)

14121 PRESSURE DEPENDENCES OF THE ELASTIC SHEAR MODULUS AND THE LATTICE INSTABILITY IN V_3Si. Ting, C.S. (Department of Physics, New York University, New York, New York 10003); Ganguly, A.K. Phys. Rev. B 9: No. 6, 2781-2783 (15 Mar 1974).

The effects of a hydrostatic pressure on the shear modulus C_s and the structural transition temperature T_m of V_3Si are studied on the basis of the Weger-Labbé-Friedel model with currently known parameters. Taking into account the charge transfer between s and d bands, our results can quantitatively account for the recent observations of Carcia and Barsch on $\partial C_s/\partial P$ and chu and Testardi on T_m. (auth)

14122 SUPERCONDUCTING CURRENT CAPACITIES OF COMPOSITE-PROCESSED LAVES PHASE TAPES, V/Hf_xZr_{1-x}. Inoue, K.; Tachikawa, K. (National Research Institute for Metals, 2-3-12, Nakameguro, Meguro-Ku, Tokyo, Japan). Appl. Phys. Lett. 25: No. 1, 94-96 (1 July 1974).

C-15 crystal-type Laves phase compounds, $V_2Hf_xZr_{1-x}$, were fabricated into a tape by a composite process in which the Laves phase layers were formed by the diffusion between the vanadium sheath and the Hf_xZr_{1-x} alloy core. In the composition range $0.4 \geq x \geq 0.3$, the composite tape showed the maximum values of superconducting transition temperature, upper critical field, and critical current density. The critical current of the tape did not degrade by winding into coils with diameters larger than 20 mm. (auth)

14123 NUCLEATION OF VORTICES IN THE SUPERCONDUCTING MIXED STATE: NASCENT VORTICES. Walton, B.L.; Rosenblum, B.; Bridges, F. (University of California at Santa Cruz, Santa Cruz, California 95064). Phys. Rev. Lett. 32: No. 19, 1047-1050 (13 May 1974).

Evidence is presented that the mixed-state order parameter at surfaces parallel to the magnetic field is strongly modulated. The minima of this modulation act as the nucleation and denucleation sites for vortices. (auth)

14124 TEMPERATURE OF THE SUPERCONDUCTING TRANSITION IN SMALL TIN PARTICLES. Morozov, Y.G.; Naumenko, I.G.; Petinov, V.I. (Institute of Chemical Physics, Academy of Sciences of the USSR, Chernogolovka). Sov. Phys.-Solid State 15: No. 10, 2050-2057 (15 Apr 1974).

Measurements have been made of the effect of packing density and of ultrasonic irradiation on the magnetic susceptibility and the super-conducting transition temperature of tin particle suspensions. (AIP)

14125 INVESTIGATION OF THE COMPOSITION DEPENDENCE OF AN INCREASE IN THE CREEP DEFORMATION IN THE Pb-In SYSTEM AT THE SUPERCONDUCTING TRANSITION TEMPERATURE. Bar'yakhtar, V.G.; Gindin, I.A.; Gubin, N.S.; Druinskii, E.I.; Lebedev, V.P.; Starodubov, Y.D.; Fal'ko, I.I. (Physicotechnical Institute, Academy of Sciences of the Ukrainian SSR, Khar'kov). Sov. Phys.-Solid State 15: No. 10, 1966-1969 (15 Apr 1974).

An investigation was made of the composition dependence of the softening effect during creep which occurred at the superconducting transition of the Pb-In alloys in a wide range of concentrations (from 0 to 20 at.%). The dependence was nonmonotonic and complex. The experimental results were interpreted using a two-band model of the superconductivity and assuming the thermally activated mechanism of plastic deformation. (auth)

14126 LIFETIMES OF QUASIPARTICLES IN A NONEQUILIBRIUM SUPERCONDUCTOR. Seminozhenko, V.P. (Donets Physicotechnical Institute, Academy of Sciences of the Ukrainian SSR). Sov. Phys.-Solid State 15: No. 10, 1945-1946 (15 Apr 1974).

A calculation is presented of the lifetimes of quasiparticles τ_R in the case of recombination accompanied by phonon emission and in the case of decay of Cooper pairs accompanied by phonon absorption. It is assumed that the superconductor under study is kept in a nonequilibrium state by a constant source, which dissociates pairs and creates an excess of quasiparticles (compared with the equilibrium state). It is shown that the times τ_R can differ considerably from the relaxation times corresponding to an equilibrium superconductor. (auth)

14127 SCATTERING OF QUASIPARTICLES BY DISLOCATIONS IN SUPERCONDUCTORS. Seminozhenko, V.P. (Physicotechnical Institute, Academy of Sciences of the Ukrainian SSR, Khar'kov). Sov. Phys.-Solid State 15: No. 10, 2088-2089 (15 Apr 1974).

The contribution of the scattering of electron excitations by dislocations to the thermal conductivity of superconductors has been estimated. The analysis indicates that dislocations as well as impurities play a major role in the kinetics of electrons in superconductors at $T \ll T_c$. (AIP)

14128 RESONANT SCATTERING OF THERMAL PHONONS BY DISLOCATIONS IN SUPERCONDUCTING ALUMINUM. O'Hara, S.G.; Anderson, A.C. (Department of Physics and Materials Research Laboratory, University of Illinois, Urbana, Illinois 61801). Phys. Rev. B 9: No. 9, 3730-3734 (1 May 1974).

Measurements of the lattice thermal conductivity in superconducting Al demonstrate the existence of a resonant phonon-dislocation interaction near 10^{10} Hz. Three different models of dislocations, each exhibiting an eigenfrequency, may be made to agree with the data. It is suggested that the dynamical behavior of dislocations at thermal amplitudes, as observed in the present measurements, may differ from the dynamical properties appropriate to ultrasonic and other techniques which employ macroscopic strain amplitudes. (auth)

14129 VOLTAGE STEPS IN THE CURRENT-INDUCED RESISTIVE STATE OF THIN-FILM TYPE-I SUPERCONDUCTORS. Huebener, R.P.; Watson, H.L. (Argonne National Laboratory, Argonne, Illinois 60439). Phys. Rev. B 9: No. 9, 3725-3729 (1 May 1974).

We report the observation of voltage steps in the current-induced resistive state in superconducting strips of lead and indium. The strips were 1.7–6 mm long, 0.1–8.0 μm thick, and 100–300 μm wide. The voltage steps are attributed to the nucleation of trains of flux tubes moving rapidly from the edge to the center of the strip. In the center, opposite tubes arriving from opposite edges annihilate each other. The moving flux-tube trains are, obviously, the outgrowth to the case of a three-dimensional type-I superconductor of the dynamic behavior of the weak-link Josephson junction, and, in particular, of the Anderson-Dayem bridge. From a simple eddy-current-damping model we have estimated the number of flux tubes existing simultaneously in a single flux-tube train. (auth)

14130 THEORY OF PHOTON-ASSISTED TUNNELING WITH RADIATION-ACTIVATED BARRIER IMPURITIES. Sherman, R.D. (Physics Department, University of Illinois, Urbana, Illinois 61801). Phys. Rev. B 9: No. 9, 3720-3724 (1 May 1974).

The addition of a new term in the conventional Hamiltonian is used to study photon-assisted tunneling for superconducting junctions containing active barrier impurities. For a sufficiently sharp molecular resonance, the impingent radiation can cause a large enhancement of the n=1 Dayem and Martin current step or a significant alteration of the dc Josephson current. The important mechanism is capture of a photon by a molecule followed by electron tunneling through the barrier. (auth)

14131 MEASUREMENT OF 50 Hz ALTERNATING CURRENT LOSSES ON SUPERCONDUCTING NIOBIUM CYLINDERS. Penczynski, P. Siemens Forsch.-Entwicklungsber.; 2: No. 5, 296-304(1973).

The ac losses of a superconductor depend very much on the production method, surface finish, and previous magnetic history of the superconductor. Such losses were measured and the following variables affecting them were studied: Meissner currents preventing magnetic flux penetration of external fields, surface currents screening the superconductor volume from changes in the applied field, and the critical c.d. determining the flux distribution inside the superconductor volume. The loss curves measured were in good agreement with theory and confirm assumptions made about penetration of magnetic flux in an actual superconductor surface and into the superconductor volume. 19 ref. (Metals Abstr.)

14132 THERMOELECTRIC EFFECTS IN SUPERCONDUCTORS. Gal'perin, Yu. M.; Gurevich, V. L.; Kozub, V. I. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksp. Teor. Fiz.; 66: No. 4, 1387-1397(Apr 1974). (In Russian).

A theory of thermoelectric effects in isotropic superconductors is developed. A normal excitation current arises in the presence of a temperature gradient which is proportional to the latter. A superconducting current arises within a massive superconductor which is equal to and opposite this current. The current can be recorded in a superconducting interferometer on basis of the phase difference of the order parameter which arises at the ends of a superconductor located at different temperatures. An additional magnetic flux, which can be measured experimentally, is produced in a closed circuit consisting of two different superconductors when the temperatures of the junctions differ. (auth)

14133 RF REACTIVELY SPUTTERED SUPERCONDUCTING NbN, FILMS. Keskar, K.S.; Yamashita, T.; Onodera, Y. (Research Institute of Electrical Communication, Tohoku University, Sendai, Japan); Goto, Y.; Aso, T. J. Appl. Phys. 45: No. 7, 3102-3105 (July 1974).

NbN, films containing various phases have been prepared by the radio frequency (rf) reactive sputtering technique and examined for their superconducting and electrical properties. These films have been found to have a wide range of upper critical magnetic fields, transition temperatures, and normal-state resistivities depending on the partial pressure of nitrogen in the sputtering atmosphere and the substrate temperature. The fcc NbN films exhibit H_{c2}(4.2 °K) ranging 150 to 230 kOe, whereas some of the Nb+Nb_2N+NbN and Nb_2N+NbN films exhibit high critical fields more than 320 kOe which are probably caused by the existence of thin connected superconducting filaments in the multiphase films at high field. (auth)

14134 PREPARATION AND PROPERTIES OF HIGH-T_c Nb-Ge FILMS. Gavaler, J.R.; Janocko, M.A.; Jones, C.K. (Westinghouse Research Laboratories, Pittsburgh, Pennsylvania 15235). J. Appl. Phys. 45: No. 7, 3009-3013 (July 1974).

Using a previously reported low-energy sputtering technique, Nb-Ge films have been prepared with superconducting T_c's up to ~23 K. High-field, x-ray, and annealing results are reported for these highest-T_c films. A discussion of the critical parameters required to achieve the highest transition temperatures in the Nb-Ge system is given. Also further arguments in support of the theories that these highest T_c's are due to the formation of the stoichiometric Nb_3Ge phase in the sputtered films are presented. (auth)

14135 ELECTRON-PHONON INTERACTION AND SUPERCONDUCTIVITY IN TRANSITION METALS AND TRANSITION-METAL CARBIDES. Klein, B.M.; Papaconstantopoulos, D.A. (Naval Research Laboratory, Washington, D. C. 20375). Phys. Rev. Lett. 32: No. 21, 1193-1195 (27 May 1974).

Using the results of self-consistent augmented-plane-wave band-structure calculations, electron mass enhancement factors and superconducting transition temperatures have been calculated for V, Nb, NbC, TaC, and HfC. Good agreement with experiment is obtained. (auth)

14136 CRITICAL PHENOMENA IN SUPERCONDUCTORS. Solinsky, J. C. Minneapolis; Univ. of Minnesota (1973). 218p. University Microfilms Order No. 74-10,591.

Thesis (Ph. D.).

Departures from the predictions of Mean Field Theory (MFT) are not usually observed because the region in temperature ΔT_c - (i.e., the critical region) over which the theory is invalid is very small (~10^{-12} K) for pure superconductors. The narrowness of this region results from the dependence of ΔT_c on the inverse of the sixth power of the zero temperature value of the temperature dependent coherence length $\xi(T)$, a parameter which measures the size of coherent superconducting regions, and is about 10^4 Å for pure superconductors. This relationship between ΔT_c and $\xi(0)$ is why in superfluid ^{4}He critical phenomena are observed ($\xi(0) \sim 2$ Å) and why MFT works so well for pure superconductors. But ΔT_c can be increased to the order of 10^{-3} K by studying dirty superconductors (i.e., the mean free path $l \ll \xi(0)$) in restricted geometry (i.e., a characteristic length $L \ll \xi(0)$). Experimental studies were carried out with 1000 Å thick dirty granular aluminum films (mass ~ 20 μg) which were evaporated onto mica substrates. The electrical conductivity and heat capacity were studied in the superconducting transition region. The resistive transition of the film was used as a thermometer in conjunction with optical heating in an ac calorimetry scheme to measure the films 5×10^{-9} J/K heat capacity. Results presented on four films indicate a rise in the heat capacity near the low temperature region of the transition where the film's resistance becomes zero. This rise peaked in two films studied to a value of up to 20 times the BCS jump in heat capacity and at a temperature of about 20 mK below the MFT transition temperature T_c^{MFT} as determined from the conductivity measurements. An applied magnetic field widened and reduced the peak in the heat capacity while shifting it to a lower temperature. These results indicate that higher order corrections are needed to recent heat capacity predictions for thin films in the transition region. (Diss. Abstr. Int., B)

14137 SUPERCONDUCTING MAGNETIZATION STUDY IN HIGH PURITY VANADIUM. Boykin, J. C. New Orleans; Louisiana State University (1973). 63p. University Microfilms Order No. 74-8338.

Thesis (Ph. D.).

Superconducting magnetization data and critical fields were obtained for a high purity (R. R. = 516) vanadium crystal over a temperature range $1.2 < t < 0.92$ ($t = T/T_c$). A dynamic technique is used to obtain superconducting susceptibility curves from which H_{c2}, H_{c1} and K_1 are easily and accurately determined. The thermodynamic and lower critical fields H_c and H_{c1} along with the Ginzburg-Landau parameter K_2 are found to be dependent on the metallurgical state of the surface whereas H_{c2} and H_{c3} are shown to be independent of surface. The critical temperature T_c is found to be 5.41 ± .01°K with $K(T_c) = 0.83 \pm .01$. The measured critical fields and Ginzburg-Landau parameters are considered in light of present theories. The ratio of the surface nucleation field to the bulk superconducting critical field, H_{c3}/H_{c2}, was also measured using the dynamic technique. It is found that the asymptotic value of the ratio at the low temperature end of the range ($t \to 0$) is 1.77 and as $t \to 1$, H_{c3}/H_{c2} also approaches 1 rather steeply. The experimental results are explained by a model proposed by Hu which assumes the superconducting interaction potential in the vicinity of the surface to be slightly depressed when compared to the bulk interaction potential. A fit of the H_{c3}/H_{c2} results to this model supply a reduction in the interaction potential of 0.9% over a distance of $1.2\xi_0 \approx 540$ Å. A few possibilities as to the cause of this phenomenon are discussed. (Diss. Abstr. Int., B)

14138 RESISTANCE PEAK AT THE SUPERCONDUCTING TRANSITION OF THIN FILMS. Carl, S. Bloomington, IN; Indiana University (1973). 93p. University Microfilms Order No. 74-4670.

Thesis (Ph. D.).

Studying the resistive properties of relatively pure thin films of tin a resistance peak near the superconducting transition was discovered. The peak reaches its maximum height in resistance within 20 millidegrees Kelvin of the superconducting transition. If the superconducting transition temperature is decreased by applying a magnetic field parallel to the surface of the film, the peak is still observed to be within 20 millidegrees of the new transition temperature. The average peak has a height of approximately one percent of the normal resistance of the film. The peak width is on the order of 20 to 30 millidegrees Kelvin. The peak is very sensitive to a magnetic field normal to the surface of the film. A field perpendicular to the surface of the film on the order of 25 gauss quenches the peak whereas a field parallel to the surface of the film 250 gauss usually increases the height of the peak compared to the zero applied field peak height. The excess conductivity of the films is larger than predicted by the Aslamazov and Larkin theory. The theory of Maki as corrected by Thompson does yield the experimentally observed excess conductivity. A magnetic field applied parallel to the surface of the film appears to sharpen the superconducting transition. The limit of this sharpening is described by the Aslamazov and Larkin theory. Thicker films of ≈3000Å thickness have the largest excess conductivity and do not exhibit a peak in zero applied field. However, at some threshold magnetic field parallel to the surface a peak appears at the transition. A larger magnetic field increases the height of the peak. Films on the order of 1000Å thick have a peak in zero applied field. A magnetic field applied parallel to the surface usually increases the height of the peak. Other investigators measured thinner films of other materials and found a similar peak near the transition in zero applied field. In all cases a field perpendicular to the surface of the film destroys the peak. A phenomenological theory is developed which fits the temperature, magnetic field, and thickness dependence discussed above. According to the theory,

the normal electrons, which are flowing parallel to the surface of the film, are scattered by the short lived Cooper pairs or fluctuations within the film. This increases the resistance of the film. The increasing size and lifetime of the fluctuations is sufficient to cause a peak in resistance at the superconducting transition of thin films. (Diss. Abstr. Int., B)

14139 NOISE OF SUPERCONDUCTOR DEVICES. Choe, H. M. Minneapolis; Univ. of Minnesota (1973). 219p. University Microfilms Order No. 74-10,495.

Thesis (Ph. D.).

Flux-flow noise in Type-II superconductors like vanadium foil was studied theoretically and experimentally. The noise spectra of a superconductor foil with finite dimensions were studied and evaluated by aid of a digital computer, looking at the behavior of single fluxoid motion. This part can also explain the steep drop at high frequencies in the flux-flow noise spectrum due to a probe size effect. Flux-flow noise and other properties of Type-II superconductors were measured in the temperature range of from 4.2°K to 1.8°K and compared with theory and a reasonable agreement was noted. Flux-flow noise and flicker noise may be generated simultaneously, but they can be separated by changing the temperature of the helium bath or the dc power level dissipated inside the device. If the heat dissipated in the device is large enough, helium bubbles will be formed and this produces a temperature gradient that modifies the flux-flow motion; this gives rise to flicker noise. Induced flux-flow noise was also studied theoretically and experimentally with the help of pick-up wires separated from the Type II superconducting foil by a thin insulating layer. The induced flux-flow noise in the pick-up wires was very small; with an insulating layer of 3500 Å we found a squared noise voltage of the order of 10^{-21} volt^2/Hz at about 1 KHz; this is about 10^6 times smaller than the flux-flow noise observed on the type II superconducting foil itself. We can obtain agreement between theory and experiment, if we assume that the fluxoid bundles (of the order of 10^6 in some cases in the cold-rolled vanadium foil) that make the primary flux-flow noise so large act as individual fluxoids as far as the induced flux-flow noise is concerned. We measured about 80% cross-correlation between the flux-flow noise and the induced flux-flow noise and between the induced noises on the pick-up wires. A Josephson junction amplifier working at cryogenic temperatures based on the Josephson effects was studied and a prototype amplifier at 30 MHz carrier frequency was made. The noise power per unit band width $S_v(f)$ of this amplifier is proportional to N^α where N is a quantum transition number and α is measured to be about 2.8. The noise performances could be optimized by changing the number N. The best result we got is a sensitivity of about 10^{-22} volt^2/Hz at about 1 mΩ source resistance. (Diss. Abstr. Int., B)

14140 ULTRASONIC ATTENUATION IN SUPERCONDUCTING CADMIUM. Robbins, R. A. Lubbock, TX; Texas Tech Univ. (1973). University Microfilms.

Thesis (Ph. D.).

Measurements have been made of the attenuation of longitudinal sound waves as a function of temperature in normal and superconducting high purity crystalline cadmium. Ultrasonic frequencies between 10 MHz and 110 MHz were propagated in each of the three principle crystallographic directions. Data were taken with the aid of a "single shot" type ^{3}He refrigerator and a phase sensitive, continuous measuring electronic system, using the conventional single ended pulse-echo method. Supplementary magnetoacoustic measurements were made to determine the electron mean free path lengths in the cadmium sample. Magnetic susceptibility measurements were also performed to determine the magnetic impurity level. Analysis of the data indicates the presence of a single, frequency independent, superconducting energy gap associated with each crystallographic direction studied. As indicated by the multiple energy gap theory of Tang, and the high ql values of the present cadmium crystal, the origin of the energy gaps detected in this work is thought to be due to electrons of only one band. (Diss. Abstr. Int., B)

14141 CORRELATION BETWEEN THE ANOMALOUS PRESSURE DEPENDENCE OF THE SUPERCONDUCTING TRANSITION TEMPERATURE IN THALLIUM AND THE TEMPERATURE DEPENDENCE OF ITS KNIGHT SHIFT. Schratter, J.; Williams, D. L. (Univ. of British Columbia, Vancouver). Can. J. Phys.; 52: No. 8, 678-686(15 Apr 1974).

A study of the Knight shift has been carried out on a single crystal of thallium. The isotropic Knight shift decreases with increasing temperature, showing a nonlinear variation which is most pronounced between 50 and 150°K. This behavior is correlated with the anomalous pressure dependence of the superconducting transition temperature at low pressure. From the superconducting data on pure Tl and Tl–Hg alloys, the volume dependence of the electronic density of states was extracted and used to derive the temperature dependence of the Knight shift. The results agree with the observed data. (auth)

Equipment and Devices

Refer also to abstracts 13314, 13342, and 14139.

14142 LOW TEMPERATURE DIRECT CURRENT COMPARATORS. Sullivan, D.B. (Cryogenics Division, IBS, National Bureau of Standards, Boulder, Colorado 80302); Dziuba, R.F. Rev. Sci. Instrum. 45: No. 4, 517-519 (Apr 1974).

This paper presents an improved version of the low temperature direct current comparator described originally by Harvey. The comparator described herein exhibits a resolution of 1.5 nA turn and provides ratios which have uncertainties of less than 4 parts in 10^{10}. An alternate approach to the shielding of the windings is discussed and a preliminary comparator based on this concept is shown to have equally good performance. The latter comparator is probably better suited to the attainment of large current ratios. (auth)

14143 A NEW APPROACH TO HIGH RESOLUTION MEASUREMENTS OF STRUCTURE IN SUPERCONDUCTING TUNNELING CURRENTS. Hebard, A.F.; Shumate, P.W. (Bell Laboratories, Murray Hill, New Jersey 07974). Rev. Sci. Instrum. 45: No. 4, 529-533 (Apr 1974).

The design of electronic circuitry is described that has the capability of measuring independently the bias dependence of the first derivatives dI/dV (dynamic conductance) and dV/dI (dynamic resistance) and the second derivatives d^2I/dV^2 and d^2V/dI^2 of a tunneling current–voltage (I–V) characteristic over a wide range of junction impedances (less than 1 Ω to greater than 10^4 Ω). Connections to the sample are four terminal so that problems with lead resistance are eliminated. Resolution in the measurement of the first derivatives is better than one part in 10^4, and problems with long-term drift are obviated by the use of feedback. Modulation levels at the sample junction, both at constant current and constant voltage, are conveniently monitored with a calibrated lock-in amplifier and can be easily changed. The circuitry has been operated successfully with voltage modulation levels across the junction ranging from 1.0 μV to 2.5 mV rms. Data are presented on Al–I–Pb and Al–I–$AuPb_2$ tunnel-junction samples to illustrate the capabilities of the system. (auth)

14144 PROCEEDINGS OF THE TWENTY-SEVENTH ANNUAL FREQUENCY CONTROL SYMPOSIUM, CHERRY HILL, NEW JERSEY, JUNE 12–14, 1973. Washington, DC; Electronic Industries Association (1973). 453p. (CONF-730622-). $6.50.

The proceedings contain 58 papers divided into sections entitled resonator theory, resonator design and measurement, surface phenomena, radiation effects in quartz crystals, frequency generation, crystal filters, frequency and time, realization of the second, lasers and rubidium gas cells, and superconductive resonators and frequency stability measurements. Separate abstracts are prepared for seven papers. (MHR)

For abstracts of individual papers see: 12806–12809, 13277, 14145, and 14146.

14145 S- AND X-BAND SUPERCONDUCTING CAVITY STABILIZED OSCILLATORS. Jimenez, J. J.; Septier, A. (Univ. Paris, Orsay, France). pp 406-413 of Proceedings of the Twenty-Seventh Annual Frequency Control Symposium. Washington, DC; Electronic Industries Association (1973).

From 27th annual frequency control symposium; Cherry Hill, New Jersey, USA (12 Jun 1973). See CONF-730622-.

The use of superconducting cavities to stabilize klystrons, Gunn diodes, IMPATT diodes and cooled tunnel diode oscillators by coupling directly the free running oscillator to the cavity allows fractional frequency fluctuations of a few 10^{-12} for an averaging time of 10 seconds. The principle of the superconducting cavity stabilized oscillator is discussed, using the injection locking model. Various sources of frequency instabilities are given. Results on stability and noise of a cooled S-band tunnel diode and X-band Gunn diode SCSO's are presented. (auth)

14146 DEVELOPMENT OF THE SUPERCONDUCTING CAVITY STABILIZED OSCILLATOR. Stein, S. R.; Turneaure, J. P. (Stanford Univ., CA). pp 414-420 of Proceedings of the Twenty-Seventh Annual Frequency Control Symposium. Washington, DC; Electronic Industries Association (1973).

From 27th annual frequency control symposium; Cherry Hill, New Jersey, USA (12 Jun 1973). See CONF-730622-.

A very high stability microwave oscillator system has been developed which has a high Q superconducting cavity as its frequency determining element. In this system, which is called a superconducting cavity stabilized oscillator (SCSO), the rf power is generated by a Gunn-Effect oscillator whose frequency is electronically tuned by a varactor diode. An intermediate frequency discriminator is used to produce a feedback voltage which maintains the oscillator at the center of the cavity resonance. An improved stabilization system is now reported which

has higher short term stability. The frequency stability of the superconducting cavity stabilized oscillator has been studied by comparing two similar oscillator systems. In the time domain, continuous period time counting techniques have been used to measure the root mean square fractional frequency fluctuations over a range of sampling times from 1 msec to 100 sec. The best stability measured is $\sigma_y(\tau) = 1.08 \times 10^{-14}$ for a sampling time, τ of 10 sec. More detailed information concerning the frequency fluctuations has been obtained in the frequency domain by spectrum analysis of the phase fluctuations over a frequency range of 20 Hz to 10 kHz. In addition, the absolute long term drift has been measured by a 45 hour comparison with a cesium atomic clock using the TV line 10 passive system for time transfer. The linear fractional frequency drift observed during the 45 hour period is 4×10^{-12} per day. (auth)

14147 MAGNETIC PROCESSING: COMMERCIAL SUPERCON. Stekly, Z. J. J.; Robinson, G. Y. Jr. Cryog. Ind. Gases; 8: No. 4, 26-28(1973).

A pilot plant superconducting magnetic separator for an industrial clay producer is described. (MHR)

14148 SUPERCONDUCTING POWER TRANSMISSION: COOL SOLUTION TO A HOT PROBLEM. Meyerhoff, R. W. (Union Carbide Corp., Tonawanda, NY). Cryog. Ind. Gases; 8: No. 4, 19-23(1973).

Research studies showing that underground superconducting transmission holds the greatest promise for mid-80's power transmission requirements are discussed in general terms under the following headings: early studies, present program, systems analysis, dielectric system development, conductor development, termination development, and cryogenic system development. (MHR)

14149 ELECTRICAL PERFORMANCE OF A LIQUID HELIUM-COOLED TRANSFORMER. Prober, D.E. (Department of Physics and Gordon McKay Laboratory of Applied Science, Harvard University, Cambridge, Massachusetts 02138). Rev. Sci. Instrum. 45: No. 6, 849-849 (June 1974).

The noise performance of an audio-frequency transformer cooled in liquid helium and combined with a low-noise amplifier is reported. It is found that the transformer, modified for operation at low temperatures, behaves nearly as a noiseless transformer for low source impedances. The minimum noise temperature of the transformer-amplifier combination is 1.8 K for a 3 Ω source resistance. The bandwidth of the cooled transformer is similar to that obtained at room temperature. (auth)

14150 AN ULTRA-LOW-NOISE PREAMPLIFIER USING SUPERCONDUCTING QUANTUM DEVICES. Davidson, A.; Newbower, R.S.; Beasley, M.R. (Division of Engineering and Applied Physics, Harvard University, Cambridge, Massachusetts 02138). Rev. Sci. Instrum. 45: No. 6, 838-846 (June 1974).

The application of superconducting (SQUID) galvanometers as low-noise preamplifiers with considerable bandwidth is explored. The important role of negative feedback in maximizing the bandwidth of these preamplifiers is carefully analyzed. Also discussed is the design and construction of superconducting impedance matching transformers suitable for making the unexcelled noise characteristics of these amplifiers available over a wide range of source impedances. A working preamplifier is described which has exhibited a maximum bandwidth of 10 kHz and noise temperatures in the liquid helium temperature range or below for all source impedances up to a few ohms. The operating characteristics of this preamplifier are compared to the best conventional room temperature amplifiers and are found to be superior for source impedances less than ~10 Ω. (auth)

14151 HIGH ACCURACY POTENTIOMETERS FOR USE WITH TEN MILLIVOLT JOSEPHSON DEVICES. II. CASCADED-INTERCHANGE COMPARATOR. Denenstein, A.; Finnegan, T.F. (Department of Physics and Laboratory for Research on the Structure of Matter, University of Pennsylvania, Philadelphia, Pennsylvania 19174). Rev. Sci. Instrum. 45: No. 6, 735-741 (June 1974).

A potentiometric technique for accurately determining a fixed voltage ratio has been developed which employs a voltbox subdivided for optimum self-calibration. The calibration procedure minimizes the effects of resistor self-heating and interconnection resistances which are commonly limiting factors. The basic theory of the technique and the design and construction of an instrument to compare a Josephson device (10 mV) and a standard cell (1 V) are described. This cascaded-interchange comparator (CIC) was evaluated in conjunction with another instrument, based on the double series-parallel exchange technique, in a series of 2 e/h measurements and direct instrument comparisons. The over-all uncertainty for the CIC was about 3 parts in 10^8 (1σ) and the direct comparisons between the two instruments agreed to within their combined uncertainty of 4 parts in 10^8. The cascaded-interchange technique should also be useful for the accurate measurement of high voltages. (auth)

14152 THEORIES OF SUBHARMONIC GAP STRUCTURES IN SUPERCONDUCTING JUNCTIONS. Hasselberg, L.-E. (Department of Theoretical Physics, The Royal Institute of Technology, Stockholm, Sweden); Levinsen, M.T.; Samuelsen, M.R. Phys. Rev. B 9: No. 9, 3757-3765 (1 May 1974).

The two theories of subharmonic gap structures in superconducting junctions, multiparticle tunneling and self-coupling due to an electromagnetic field set up by the ac Josephson current, are analyzed when microwaves are applied. Both theories give the same location in voltage for the microwave-induced satellites and the same microwave-power dependence for the subharmonic gap structure and the satellites. Therefore other properties than these are to be considered in order to distinguish between the two theories. We suggest that self-coupling is the main cause of the subharmonic gap structure. (auth)

14153 EFFECT OF RESONANCE SCATTERING ON JOSEPHSON CURRENT THROUGH A SUPERCONDUCTOR–NORMAL-METAL–SUPERCONDUCTOR JUNCTION. Kumar, P.; Gupta, S.N. (Department of Physics, University of Roorkee, Roorkee, India 247667). Phys. Rev. B 9: No. 9, 3935-3937 (1 May 1974).

The effect of resonance scattering due to finite but small concentration of localized nonmagnetic impurities on the zero-bias Josephson current through a superconductor–normal-metal–superconductor (SNS) junction is studied at T = 0 °K. The ratio of the barrier supercurrent of the impure SNS junction to that of the pure one is found to decrease with an increase in the impurity concentration. This behavior is completely different from that of nonlocalized nonmagnetic impurities, where this ratio is exactly equal to one. At $\zeta = 0$ (ζ is a measure of the impurity concentration) our result agrees exactly with that of Ishii for the pure case. (auth)

14154 SELF-RESONANCE IN CYLINDRICAL JOSEPHSON JUNCTIONS. Nerenberg, M.A.H.; Blackburn, J.A. (Department of Applied Mathematics, University of Western Ontario, London, Ontario, Canada). Phys. Rev. B 9: No. 9, 3735-3738 (1 May 1974).

The I–V characteristics of self-resonant cylindrical Josephson junctions in the presence of parallel applied magnetic fields have been calculated using a first-order perturbation technique. (auth)

14155 MECHANICAL ANALOGUE OF ACTIVE JOSEPHSON TRANSMISSION LINE. Nakajima, K.; Yamashita, T.; Onodera, Y. (Research Institute of Electrical Communication, Tohoku University, Sendai, Japan). J. Appl. Phys. 45: No. 7, 3141-3145 (July 1974).

The mechanical analogue of the sine-Gordon equation, which includes the effects of loss and the effect of a distributed bias source is constructed. The mechanical analogue itself is a active line transmitting kinks which are a kind of the solitons given by the sine-Gordon equation. The various vortex interactions on an active Josephson transmission line can be demonstrated vividly by using the mechanical line. Our distributed bias source which consists of a series of air nozzles blowing against each of aluminum disks is able to supply energy to kinks on the line. The analogue gives a quick and new physical insight into the highly nonlinear behavior. (auth)

14156 EXPERIMENTAL DETERMINATION OF OPTIMUM OPERATING CONDITIONS OF A SUPERCONDUCTING INTERFEROMETER. Pascal, D.; Sauzade, M. (Institut d'Electronique Fondamentale, Laboratoire associé au CNRS, Bâtiment 220, Université de Paris Sud, 91405 Orsay, France). J. Appl. Phys. 45: No. 7, 3085-3090 (July 1974).

A superconducting interferometer (SQUID) behaves as a nonlinear impedance, the value of which changes periodically when an linearly increasing flux is applied to it. Conditions of utilization of this device, when stimulated by an rf flux to obtain maximum sensitivity, where studied and were found to satisfy the relation $k^2Q \simeq 1$ and $2\pi L_s i_c/\phi_0 \simeq 1$. Experimental results show that the signal response increases as $\sqrt{f}$ and the sensitivity obtained at 246 MHz is $4 \times 10^{-5} \phi_0$ Hz$^{-1/2}$. (auth)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 14091 and 14269.

14157 (IAE-2236) GALERKIN METHOD FOR DIFFUSION EQUATIONS. Part 1. General Scheme of Method and Approach to the Selection of Coordinate Functions. Lebedev, V. I.; Tsapelkin, E. S.; Kurchenkova, G. I. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1972. 14p. (In Russian). INIS.

This study presents the Galerkin method for solving multidimensional diffusion equations with constant coefficients. A number of methods are given for constructing almost orthonormalized, strongly minimal systems of coordinate functions. A qualitative estimate is given for ordering of coordinate functions, and a general scheme of a method for calculating two-group problems is presented. (tr-auth)

14158 (JINR-P3-7824) CONFINEMENT OF NEUTRAL PARTICLES WITH MAGNETIC MOMENT IN FIELDS OF MULTIPOLAR MAGNETS. Matora, I. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1974. 10p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

It is shown, that keeping of slow polarized neutrons and other neutral particles is simplier if one uses multipolar magnets with odd number of the same name poles. (auth)

14159 (JINR-P4-7831) PORES EFFECT ON ULTRACOLD NEUTRON ABSORPTION IN TRAP WALLS. Ignatovich, V. K (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1974. 17p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

Possible tunneling of ultracold neutrons (UCN) into the wall pores is considered. The value for the porosity is obtained which can cause the value of the UCN absorption coefficient in the traps observed in the experiment. (1 figure) (auth)

14160 PRACTICAL CONSIDERATIONS IN SOLVING NEUTRONICS PROBLEMS BY THE MONTE CARLO METHOD. Parker, J. B. (United Kingdom Atomic Energy Authority, Aldermaston, Eng.). Ann. Nucl. Sci. Eng.; 1: No. 3, 169-183(Mar 1974).

The practical problems associated with staging large scale Monte Carlo neutronics problems on an electronic computer are reviewed. Before solving the problem the basic nuclear data require to be first assessed, then processed in such a way as to allow the subsequent Monte Carlo calculations to proceed flexibly. This aspect of solving Monte Carlo neutronics problems is reviewed. After different types of neutronics calculations, each of which presents its own individual problems, are defined, two case histories are described. A final summary describes present attitudes towards the subject. (auth)

14161 ANALYSIS OF NON-EQUILIBRIUM THERMAL NEUTRON FIELDS IN THE FOURIER FREQUENCY PLANE. Ibrahim, K. M. Urbana, IL; University of Illinois (1973). 265p. University Microfilms Order No. 74-12,050.

Thesis (Ph. D.).

The development of nonequilibrium thermal-neutron field and its approach to equilibrium is studied theoretically. The experiment analyzed is a neutron thermalization experiment; however, it differs from the traditional die-away and wave experiments: the initial energy and space distributions of the source are designed to deviate from the equilibrium distributions in these variables. The comparison of theory and experiment is made in the Fourier frequency plane via the Ratio Test (RT), defined as the ratio of the real to the imaginary part of the Fourier transform (in time) of the detector response. The transport of neutrons is modeled by diffusion theory to study infinite and finite graphite assemblies. The RT for two detectors, namely, BF-3 and Cd-48, are obtained for an infinite and some finite assemblies. The RT of the two detectors are found to be similar in the small and large frequency regions; however, the Cd-48 RT behaves very differently from the BF-3 RT in the intermediate frequency range. The sensitivity of the RT to a change in the neutronic parameters is also studied. It is found that in an infinite medium the RT is sensitive to absorption cross section only and in a finite medium ($B^2 = 1.133 \times 10^{-3}$ cm^{-2}) it is most sensitive to inelastic scattering cross section. A system dispersion law for graphite is derived from the low frequency behavior of the BF-3 RT. Complex spectra and complex average energy are presented, and their asymptotic behaviors at large and small frequencies are discussed. (RWR)

Nuclear Properties and Reactions, A ≤ 5

Refer also to abstracts 13820, 14023, 14030, and 14343.

14162 $^3H(^3He, n)^5Li$ REACTION FROM 14 TO 26 MeV. Chang, C.C.; Ventura, E. (Department of Physics, Stanford University, Stanford, California 94305). Phys. Rev. C 9: No. 4, 1671-1672 (Apr 1974).

The excitation function for the $^3H(^3He, n)^5Li$ reaction is obtained for E_r = 14-26 MeV at $\theta_{lab} = 20°$. The result shows a broad resonance at $E_r = 20.5 \pm 0.8$ MeV. The existence of such a resonance is consistent with a resonance found in the $^3H(^3He, \gamma_1)^6Li$ capture reaction. (auth)

14163 POLARIZATION TRANSFER IN $^3He(d, d)^3He$ ELASTIC SCATTERING. Lovoi, P.A.; Salzman, G.C.; Ohlsen, G.G.; Mitchell, C.K.; Grüebler, W. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87544). Phys. Rev. C 9: No. 4, 1336-1339 (Apr 1974).

Measurements of four vector-to-tensor and six tensor-to-tensor polarization-transfer coefficients for the elastic scattering of polarized deuterons by ^3He are reported. Data were obtained at the laboratory angle 30° for energies in the range 5-9 MeV. (auth)

14164 RENORMALIZED BRUECKNER-HARTREE-FOCK CALCULATIONS OF ^4He AND ^{16}O WITH CENTER-OF-MASS CORRECTIONS. Becker, R.L.; Davies, K.T.R.; Patterson, M.R. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). Phys. Rev. C 9: No. 4, 1221-1242 (Apr 1974).

It is emphasized that the propagator-renormalized Brueckner-Hartree-Fock self-consistent field theory (RBHF) is an improvement over the unrenormalized Brueckner approximation plus rearrangement energy corrections for two main reasons: (I) Through the renormalization of the off-diagonal matrix elements of the single-particle potential in a fixed basis the shape and size of the field are modified, leading to increased nuclear radii and improved density distributions which affect the expectation values of all observables; (II) through the solution of coupled equations for the "true" occupation probabilities, occupancy-rearrangement effects are calculated self-consistently rather than merely to lowest order. For an accurate test of the RBHF approximation in light nuclei, c.m. corrections to the calculated properties are quite important. Two ways of making the c.m. corrections, discussed earlier, are applied and compared in calculations with the Reid soft-core and Hamada-Johnston interactions for ^4He and ^{16}O. The RBHF equations are solved by matrix diagonalization in the harmonic oscillator basis. The well depth of the oscillator reference potential for virtual "particle" states is determined by requiring self-consistency, for the low-lying "particle" states, with an average off-energy-shell RBHF self energy. The binding energies are in good agreement with experiment, as is the radius of ^4He, while the radius of ^{16}O is about 8% too small. A careful comparison of separation energies with experiment is made; c.m. corrections, the effect of spuriosity (presence of excited c.m. components) in the $0s_{1/2}$ hole state in ^{15}O or ^{15}N, and second- and third-order rearrangement energies calculated earlier, are included. Details of density distributions and electron elastic scattering form factors are given. The possible existence of a dip in the proton density at the center of the alpha particle is discussed. The need for higher dimensionality in the calculation for form factors and properties of unbound single-particle states is established. (auth)

14165 $^3He(\gamma,d)^1H$ CROSS SECTION FROM 10 TO 21 MeV. Chang, C.C. (University of Maryland, Department of Physics, College Park, Maryland 20742); Dodge, W.R.; Murphy, J.J. II. Phys. Rev. C 9: No. 4, 1300-1308 (Apr 1974).

A measurement of the $^3He(e,d)^1H$ 90° differential cross section between 10 and 21 MeV was made. The $^3He(e,d)^1H$ cross section was converted into a $^3He(\gamma,d)^1H$ cross section. The shape of the $^3He(\gamma,d)^1H$ cross section agrees with recent theoretical calculations. We find no evidence for the anomalies (structure) in the $^3He(\gamma,d)^1H$ 90° differential cross section at excitation energies of 14.5 and 19.5 MeV reported in two recent experiments. (auth)

14166 ANALYZING-POWER MEASUREMENTS IN THE $^3H(\vec{p}, n)^3He$ REACTION. Jarmer, J.J.; Haight, R.C.; Simmons, J.E.; Martin, J.C. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87544); Donoghue, T.R. Phys. Rev. C 9: No. 4, 1292-1299 (Apr 1974).

Angular distributions of the analyzing power of the reaction $^3H(\vec{p}, n)^3He$ have been measured at proton energies of 6.00, 9.96, and 13.55 MeV. These data are compared with available neutron-polarization data for the same reaction on a point-by-point basis and by means of associated Legendre polynomial coefficients. In contrast to the

comparison below 4 MeV, no significant difference exists above 6 MeV between the two observables at the same energies and angles. The data are also compared with R-matrix calculations based on the parameter sets of Werntz and Meyerhof. The previously reported excitation function for the analyzing power at $\theta_{c.m.} = 45°$ from 1.5 to 12 MeV is documented further. (auth)

14167 NEUTRON-PROTON SCATTERING AT A FEW MeV. Lomon, E. (Laboratory for Nuclear Science, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139); Wilson, R. Phys. Rev. C 9: No. 4, 1329-1335 (Apr 1974).

In this paper we reanalyze the np scattering data at a few MeV; we confirm, as previously suggested by Hopkins and Breit, that the np interaction models all predict the angular distribution well. Any further angular-distribution measurements must be very precise to contribute further to our knowledge. (auth)

14168 ANALYSIS OF THE PARITY-NONCONSERVING AMPLITUDES OF THE REACTIONS $n+p \rightarrow d+\gamma$ AND $n+d \rightarrow t+\gamma$. McKellar, B.H.J. (School of Physics, University of Melbourne, Parkville, Victoria, Australia 3052). Phys. Rev. C 9: No. 5, 1790-1794 (May 1974).

We display the invariant amplitudes for the reaction $n + p \rightarrow d + \gamma$ in the absence of restrictions imposed by parity conservation, and demonstrate that Danilov's result that the circular polarization of the γ depends only on the isoscalar parity-nonconserving interaction, and that the asymmetry of the γ with respect to the neutron spin direction depends only on the isovector parity-nonconserving interaction, holds up to corrections of order $(\mu_n + \mu_p - \mu_d)/(\mu_p - \mu_n) \sim 0.005$. It is also pointed out that essentially the same amplitudes can be used to describe the reaction $n + d \rightarrow t + \gamma$. (auth)

14169 RATIONALIZATION OF MEASUREMENTS OF THE ^{4}He(γ,n)^{3}He CROSS SECTION. Irish, J.D.; Johnson, R.G.; McNeill, K.G. (Department of Physics, University of Toronto, Toronto, Ontario, Canada M5S 1A7); Jury, J.W. Phys. Rev. C 9: No. 5, 2060-2062 (May 1974).

Experiments to measure the photoneutron yield from a liquid ^{4}He target as a function of beam intensity have been carried out. They show that the most recent measurements of the photoneutron cross section with liquid helium targets can be made consistent with each other, and that the results are then not inconsistent with measurements of the ^{4}He(γ,n)^{3}He cross section using gaseous targets. (auth)

14170 SPIN AND ISOSPIN EFFECTS IN π-^{4}He SCATTERING. Franco, V. (Physics Department, Brooklyn College of the City University of New York, Brooklyn, New York 11210). Phys. Rev. C 9: No. 5, 1690-1693 (May 1974).

We derive the amplitude for π-^{4}He elastic collisions, including all multiple scattering, spin-flip, and charge-exchange effects, in the Glauber approximation. A totally antisymmetric ^{4}He ground-state wave function, and πN elastic scattering amplitudes obtained from phase-shift analyses (through G waves when necessary) are used as input. The results are applied to π-^{4}He total cross sections below 1.2 GeV and compared with measurements. The real part of the π-^{4}He forward elastic scattering amplitude is calculated and compared with dispersion-relation results. The differential cross section for π-^{4}He elastic scattering is calculated for pion energies between 50 and 1120 MeV and compared with data. (auth)

14171 CLUSTER MODEL AND THE PHOTODISINTEGRATION OF ^{6}Li. Shakin, C.M.; Weiss, M.S. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). Phys. Rev. C 9: No. 5, 1679-1686 (May 1974).

The total cross section for the photodisintegration of ^{6}Li, leading to three-body final states is considered in a sequential decay model. Various cluster decompositions of the bound and continuum states are studied. The influence of the (^{3}H+^{3}He) channel on the photoeffect is considered in a schematic coupled-channel model. The models investigated are able to provide a qualitative description of the data. The cluster model for ^{6}Li appears to provide a more satisfactory over-all description than the shell model. Various open questions remain concerning the importance of nonsequential amplitudes. (auth)

14172 POLARIZATION IN n-d SCATTERING AT 16.8- AND 21.1-MeV INCIDENT NEUTRON ENERGY. Morris, C.L.; Rotter, R.; Dean, W.; Thornton, S.T. (Department of Physics, University of Virginia, Charlottesville, Virginia 22901). Phys. Rev. C 9: No. 5, 1687-1689 (May 1974).

Polarized neutrons from the reaction ^{3}H(d,$\vec{n}$)^{4}He were used to measure n-d elastic scattering polarizations at 16.8 and 21.1 MeV. The results agree well with polarizations from the charge symmetric p-d reaction. The data also follow the trend of recent theoretical calculations. (auth)

14173 NEUTRON-DEUTERON DIFFERENTIAL CROSS SECTIONS AT 35.0 AND 46.3 MeV. Brady, F.P.; Broste, W.B.; Wang, J.C. (Crocker Nuclear Laboratory and Department of Physics, University of California, Davis, California 95616); Romero, J.L.; Martens, P. Phys. Rev. C 9: No. 5, 1784-1789 (May 1974).

Differential cross sections have been measured for nd and pd scattering at 35.0 and 46.3 MeV. Only cross sections for c.m. angles $\gtrsim$ 90° have been measured in this work, which is in part a higher precision remeasurement of earlier nd cross sections and whose main purpose has been to check possible nd-pd differences which appeared in the earlier measurements at 36.0 and 46.3 MeV. Absolute nd cross sections of $\simeq$5% precision, obtained by normalization to precision np cross sections, are compared with absolute pd cross sections measured at the University of California at Los Angeles. The differences in this comparison and in the nd-pd relative cross sections measured here are smaller than indicated by the previous measurements. However, some systematic differences do appear to exist at angles near the cross-section minima and beyond. (auth)

14174 STUDY OF SPURIOUS EFFECTS IN NON-LOCAL EQUATIONS. Krause, T. O. Columbus, OH; Ohio State Univ. (1973). 147p. University Microfilms Order No. 74-10,991. Thesis (Ph. D.).

The generation of spurious states by nonlocal potentials is studied with particular attention to continuum bound states (CBS) which are positive energy wave functions with the asymptotic character of bound states. It is shown that CBS appear in the solutions to the integral equation for the physical wave functions at some energy if and only if the Fredholm determinant of the integral equation vanishes for that energy. In this case the most general solution to the integral equation contains an arbitrary amount of the CBS solutions in addition to the usual scattering solution. The form of the nonlocal potential which produces CBS is examined, and it is found that in order for such asymptotic behavior to appear the potential must contain a factor which cancels the effect of the Green's function in the integral equation. The solutions to the remaining integral equation no longer reflect the character of the Schrödinger differential equation from which the integral equation was derived, and they need not behave in the usual way at large distances. The one term Tabakin potential is shown to possess the property of cancellation of the Green's function. The two term Case-IV potential of Mongan does not have this property; the spuriousness associated with the Mongan potential is thus other than that of CBS. The problem of obtaining an equation for a single particle in an antisymmetrized multiparticle system is examined, and the resulting single particle equation is shown to be nonlocal. It is demonstrated that the redundant solutions of such an equation can be CBS. In problems where one wishes to approximate the potential in the single particle equation it is shown that a knowledge of how to generate the CBS redundant solutions can lead to a better approximate potential. The potential of Ghirardi and Rimini is shown to possess the property of cancellation of the Green's function. Thus it can be used to generate CBS. Another potential is constructed which is equivalent to the Ghirardi-Rimini potential but is more convenient to use when it is desired to increase the number of CBS wave functions generated by a given potential. To demonstrate that these CBS are physically reasonable wave functions they are used to construct simple nuclei. With few parameters a 5% agreement with experimental values is obtained for nuclear radii up to A = 16 and for binding energies between A = 4 and A = 16. (Diss. Abstr. Int., B)

14175 NEW ESTIMATE OF THE COULOMB ENERGY OF ^{3}He. Okamoto, K. (Univ. of New South Wales, Kensington, Australia); Horlike, M. Lett. Nuovo Cim.; 10: No. 6, 247-252(8 Jun 1974).

It is shown that the effect of the new measurement of the helium-3 charge form factor is to reduce the Coulomb energy of helium-3 by about 1%. It is argued that the Coulomb energy could be even smaller than 0.60 MeV if various corrections are taken into account. (JFP)

14176 NUCLEON-NUCLEON INTERACTION AND THE NUCLEAR PROBLEM OF THREE BODIES. Akhmadkhodzhaev, B.; Zubarev, A. L. (Tashkent State Univ.). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 2, 70-74(1974). (In Russian).

The study considers potentials without repulsion in the nuclear problem of three bodies. A study is made of the dependence of observed three-particle binding energies of tritium and lengths of nd-scattering as a function of the form of the potential and of the singlet parameters. (BJR)

14177 2$^-$ THRESHOLD STATE IN ^{8}Be. Arnold, L.G.; Seyler, R.G. (Department of Physics, The Ohio State University, Columbus, Ohio 43210); Brown, L.; Bonner, T.I.; Steiner, E. Phys. Rev. Lett. 32: No. 16, 895-897 (22 Apr 1974).

The 2$^-$ level in ^{8}Be at the threshold for the reaction ^{7}Li(p,n)^{7}Be is shown to be a virtual state relative to threshold. A description of the state as an S-matrix pole in the scattering-length approximation gives a

good account of its properties as observed in different reaction channels, and, in particular, removes an apparent contradiction about its width as observed through particle and γ-ray channels. The width of the 2⁻ state is found to be about 50 keV. (auth)

14178 OFF-SHELL EFFECTS IN PION-DEUTERON ABSORPTION. Goplen, B.; Gibbs, W.R. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87544); Lomon, E.L. Phys. Rev. Lett. 32: No. 18, 1012-1015 (6 May 1974).

The cross section for the process $\pi^+ + d \rightarrow p + p$ is calculated using a π–N t matrix obtained from a Lagrangian formalism. The t matrix is provided with a suitable cutoff to damp the large (off-shell) momentum components and the total cross section is found to be strongly dependent on the cutoff range parameter taken, i.e., to how fast the t matrix falls off as it is taken off shell. It is argued that this is to be expected physically and that this sensitivity might provide a means of studying the π–N off-shell t matrix. (auth)

14179 KINEMATICALLY COMPLETE MEASUREMENT ON THE REACTION ^{3}H(n, np) AT $\theta_n = 0°$. Kecskeméti, J.; Czibók, T. (Central Research Institute for Physics, Budapest, Hungary). Phys. Rev. Lett. 32: No. 19, 1063-1067 (13 May 1974).

The differential cross section of the reaction ^{3}H(n, np) was measured at $\theta_n = 0°$. Because of the applied special geometry the experimental data extend over a large fraction of the phase space, including several final-state interaction regions as well as regions far from the dominance of the quasi-two-body processes. This offers the possibility of extracting neutron-neutron scattering parameters and obtaining simultaneously additional information on the N-N potentials and three-body forces in the frame of an exact three-body calculation. (auth)

14180 ANALYSIS OF THE ^{4}He(p,2p)^{3}H REACTION. Roos, P.G. (Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742 and Institut de Physique Nucléaire, Orsay, France). Phys. Rev. C 9: No. 6, 2437-2439 (June 1974).

Calculations of the ^{4}He(p,2p)^{3}H reaction in the distorted wave impulse approximation do not reproduce the experimental data. The recent agreement obtained using a less sophisticated reaction model would seem to arise from the use of total cross sections which are too large. (auth)

14181 PROTON FORM FACTOR FROM 0.15 TO 0.79 fm^{-2}. Murphy, J.J. II; Shin, Y.M.; Skopik, D.M. (Saskatchewan Accelerator Laboratory, University of Saskatchewan, Saskatoon, Canada S7N 0W0). Phys. Rev. C 9: No. 6, 2125-2129 (June 1974).

The absolute electron-proton elastic scattering cross section has been measured by detecting the recoil protons. The proton charge form factor has been extracted for values of the square of the momentum transfer between 0.15 and 0.79 fm^{-2}. The rms charge radius determined from these measurements is 0.81 ± 0.04 fm. (auth)

14182 MAGNETIC MOMENT OF THE DEUTERON AND SPIN-ORBIT POTENTIALS. Bergstrom, J.C. (Saskatchewan Accelerator Laboratory, University of Saskatchewan, Saskatoon, Canada S7N OWO). Phys. Rev. C 9: No. 6, 2435-2436 (June 1974).

The contribution to the magnetic moment of the deuteron due to the influence of a spin-orbit term in the nucleon-nucleon interaction is reconsidered, in view of apparent errors in previous estimates. (auth)

14183 TRITON BINDING ENERGIES WITH TWO-BODY RADIAL-DISTORTION UNITARY TRANSFORMS. Lavine, J.P. (Department of Physics and Astronomy and Center for Theoretical Physics, University of Maryland, College Park, Maryland 20742 and Physique Nucléaire Théorique, Université de Liège, Sart Tilman, B-4000 Liège 1, Belgium); Stephenson, G.J. Jr. Phys. Rev. C 9: No. 6, 2095-2101 (June 1974).

We determine the triton binding energies for a class of potentials that arise from radial-distortion unitary transformations. These potentials are phase-shift equivalent to a two-term Yukawa potential, which represents an average of the $^3S_1$ and $^1S_0$ nucleon-nucleon potentials. We solve an angular-momentum-decomposed version of the Faddeev-Lovelace equations that we have developed, in order to obtain the three-body binding energy E_T. We observe that E_T varies slightly with these potentials and we find that they yield similar deuteron wave functions in accord with the results reported by Haftel. We discuss some evidence on the sensitivity of nuclear matter and three-body calculations to off-shell variations of the two-body t matrices. (auth)

14184 UNITARY POLE EXPANSION APPLIED TO THE TRINUCLEON PROBLEM. Harper, E.P. (Dublin Institute for Advanced Studies, Dublin, Ireland and Computer Laboratory, University College, Dublin, Ireland). Phys. Rev. C 9: No. 6, 2106-2113 (June 1974).

The unitary pole expansion of a central local potential effective in $^1S_0$ and $^3S_1$ two-nucleon states is applied to the calculation of the trinucleon bound state and the nucleon-deuteron doublet and quartet scattering lengths. An iteration method is used to solve the Faddeev equations in both cases and Padé techniques used to find the scattering lengths. The convergence rate of the Padé approximants is found to be good in both the doublet and quartet channels and a three-term unitary pole expansion is found to give fair agreement with the exact results for the trinucleon binding energy and the scattering lengths. (auth)

14185 VECTOR-MESON EXCHANGE CURRENTS IN THE TRITON BETA DECAY. Jaus, W. (Institut für Theoretische Physik der Universität Zürich, 8001 Zürich, Switzerland). Phys. Rev. C 9: No. 6, 2459-2462 (June 1974).

The low-energy theorem and the vector-dominance model is used to derive the vector-meson exchange current in terms of pion photoproduction amplitudes. The corresponding correction to the Gamow-Teller matrix element for the triton β decay is found to be of the same order of magnitude as the correction due to the pion exchange current. (auth)

14186 THEORY OF THE ^{3}He ELECTRIC FORM FACTOR. Lehman, E. S. Stanford, CA; Stanford University (1973). 147p. University Microfilms Order No. 74-6503.

Thesis (Ph. D.).

The problem of the position of the zero of the electric form factor of ^{3}He and the large size of the observed secondary maximum, which are not obtainable with realistic two body forces in the Faddeev equations, is discussed. Corrections to the single impulse approximation arising from vector dominance of the incident virtual photon are calculated. It is shown that such shadowing effects have neither the shape nor the magnitude to fit both the position of the zero and the size of the secondary maximum. The hyperspherical harmonic expansion for the trinucleon bound state wave function is reviewed. It is then argued that the sample physical reasoning which can be used to support the two body boundary condition model of strong interactions can be used to predict a similar but explicitly three body effect for the three nucleon interaction. A three body boundary condition imposed on the lowest order hyperharmonic contribution to the three body bound state gives a good quantitative fit to the ^{3}He electric form factor in the region q^2 greater than 10 F^{-2}, when the position of the zero is fit by adjusting the boundary hyperradius. This result is shown not to be affected by the inclusion of S′,D or other higher states. It is also not affected by taking into account the long range tails of external OBE potentials. By way of extension, a similar fit is presented for the ^{4}He form factor with similar results. Also the possibilities for refinements of the model and its use in systems other than the trinucleon bound state are discussed. (Diss. Abstr. Int., B)

14187 INADEQUACY OF THE BRUECKNER-HARTREE-FOCK-APPROXIMATION. Zabolitzky, J. G. (Univ., Bochum, Ger.). Z. Phys.; 267: No. 2, 161-163(Mar 1974).

Some Brueckner-Hartree-Fock calculations for the nuclei ^{4}He, ^{12}C and ^{16}O are reported using different prescriptions for the intermediate-state particle spectrum employed in the evaluation of the Brueckner G-matrix and different realistic nucleon-nucleon potentials. It is shown that almost any point of the relevant region of the binding energy vs. rms radius-plane may be reached. It is clearly necessary, therefore, to reduce this ambiguity of the formalism by taking into account self-consistently at least the three-body Bethe-Faddeev equation. (GE)

14188 UNITARY POLE APPROXIMATION AND T-MATRIX PERTURBATION THEORY IN TRITON CALCULATIONS. Siebert, B.; Levinger, J. S. (Resselaer Polytechnic Inst., Troy, NY). Z. Phys.; 266: No. 2, 95-101(Jan 1974).

We find that the quality of the fits of the UPA t-matrix to the exact t-matrix for a given potential does not depend strongly on specific features, such as locality or inclusion of spin orbit forces in the potential. The accuracy of the UPA fits suggests the employment of t-matrix perturbation theory in triton ground-state calculations. The accuracy of first order t-matrix perturbation theory is satisfactory for the rank-two separable tensor Tabakin potential. (5 figures, 2 tables) (auth)

Nuclear Properties and Reactions, 6 ≤ A ≤ 19

Refer also to abstracts 13693, 13928, 14024, 14162, 14164, 14174, 14187, 14221, 14222, 14230, 14268, 14343, and 14346.

14189 THREE-BODY FINAL STATES IN ^{16}O + ^{12}C-INDUCED REACTIONS: THE STRUCTURE OF ^{24}Mg AT HIGH EXCITATION. Wieland, R.; Stokstad, R.; Gobbi, A.; Shapira, D.; Chua, L.; Sachs, M.W.; Bromley, D.A. (Wright Nuclear Structure Laboratory, Yale University, New Haven, Connecticut 06520). Phys. Rev. C 9: No. 4, 1474-1492 (Apr 1974).

A kinematically complete study has been made of the $^{12}C + {}^{16}O \rightarrow {}^{12}C + {}^{12}C + \alpha$ and $^{12}C + {}^{16}O \rightarrow {}^{20}Ne + \alpha + \alpha$ reactions at $E_{^{16}O} = 58.3$ MeV (lab). α particles were detected at a mean laboratory angle of 2°, while the remaining reaction products were observed in coincidence by two large-area position-sensitive detectors placed symmetrically about the beam axis and subtending angles in the range $15° \leq \theta_{lab} \leq 75°$. Particle identification was based on the reaction kinematics. Intense yields to the lowest four states of ^{20}Ne were observed, with a significant fraction thereof proceeding through well defined intermediate states in ^{24}Mg. The predominant interaction in the $^{12}C + {}^{12}C + \alpha$ final state appears to involve $^{12}C + \alpha$ corresponding to an excited state at ^{16}O near 10 MeV excitation. No evidence was found for a $^{12}C + {}^{12}C$ final state interaction, i.e., for quasimolecular states in ^{24}Mg in the region of excitation $21 \leq E^* \leq 29$ MeV. The predictions of a Hauser-Feshbach statistical model agree rather well with the observed $^{20}Ne + \alpha + \alpha$ yields. A selected portion of the $^{12}C + {}^{12}C + \alpha$ yield, not necessarily proceeding through an excited state in ^{16}O, is accounted for by a statistical model assuming formation and decay of compound states in ^{24}Mg. (auth)

14190 $^{19}F(\alpha, t)^{20}Ne$ REACTION AT 28.5 MeV. Obst, A.W.; Kemper, K.W. (Department of Physics, The Florida State University, Tallahassee, Florida 32306). Phys. Rev. C 9: No. 4, 1643-1645 (Apr 1974).

The measured $^{19}F(\alpha, t)^{20}Ne$ angular distributions of Hansen et al. at 28.5 MeV to the first 0^+-2^+-4^+ states have been reanalyzed in terms of the collective-model coupled-channel Born-approximation theory. The "j-forbidden" 4^+ cross section at 4.247 MeV is well described by the theory, while the allowed transitions show little change from the distorted-wave Born-approximation results. Limited excitation-function measurements of the $^{19}F(\alpha, t)^{20}Ne$ reaction from 25 to 26 MeV show little structure, indicating little compound contribution to the "allowed" and "j-forbidden" transitions. (auth)

14191 CHARGE-EXCHANGE REACTIONS ON LIGHT NUCLEI IN A MULTIPLE-SCATTERING FORMALISM. Kaufmann, W.B.; Jackson, J.C.; Gibbs, W.R. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87544). Phys. Rev. C 9: No. 4, 1340-1351 (Apr 1974).

We have calculated single and double charge exchange of pions on ^9Be, ^{13}C, ^{11}B, and ^{18}O. The results are in rough agreement with the currently available experimental results. (auth)

14192 $^{13}C(^6Li, \alpha_0)^{15}N$ REACTION FOR $E_{^6Li} = 7$-17 MeV. Courtney, W.J.; Kemper, K.W.; Moore, G.E.; White, R.L. (Department of Physics, The Florida State University, Tallahassee, Florida 32306). Phys. Rev. C 9: No. 4, 1273-1275 (Apr 1974).

The $^{13}C(^6Li, \alpha_0)^{15}N$ reaction has been studied in the incident-energy range of 7-17 MeV at laboratory angles of 5 and 172.5°. These data are compared with previously reported $^{12}C(^7Li, \alpha_0)^{15}N$ data over the same energy range in the compound system ^{19}F. Resonant structure is observed in both reactions at $\theta = 5°$ with correlated structure at 24.7, 27.3, and 28 MeV excitation in ^{19}F. Interpretation of this structure in terms of the resonant-cluster-transfer model of Carlson and Johnson is discussed. (auth)

14193 ALPHA-SPALLATION CROSS SECTIONS AT 920 MeV (230 MeV/N) IN ^{27}Al, ^{16}O, ^{12}C, AND ^9Be, AND APPLICATION TO COSMIC-RAY TRANSPORT. Radin, J.R. (Tel-Aviv University, Department of Physics & Astronomy, Ramat Aviv, Israel); Smith, A.R.; Little, N. Phys. Rev. C 9: No. 5, 1718-1729 (May 1974).

We investigated the effects on cosmic rays from spallation reactions between cosmic rays and interstellar helium. The spallation cross sections were measured by exposing thin-sandwich targets to the 920-MeV (230-MeV/N) external α-particle beam of the 184-in. cyclotron at Lawrence Berkeley Laboratory. Cross sections were measured for the production: from ^{27}Al of ^{18}F (12.5 ± 0.5 mb); from ^{16}O of ^{15}O (46.4 ± 2.7 mb), ^{13}N (6.75 ± 0.5 mb), ^{11}C (18.5 ± 0.9 mb), and ^7Be (18.5 ± 1.3 mb); from ^{12}C of ^7Be (20.0 ± 1.2 mb); and from ^9Be of ^7Be (12.6 ± 0.8 mb). We constructed spallation cross-section ratios for the ratio of α-particle-induced to proton-induced reactions ($\equiv \Sigma^{\alpha}_{p}$). We parametrized this ratio by the nucleon difference (ΔA) between the target initial and final states and we fitted this ratio $[\Sigma^{\alpha}_{p}(\Delta A)]$ to a linear function in ΔA. We used this function $[\Sigma^{\alpha}_{p}(\Delta A)]$ to obtain all of the α-particle-spallation cross sections from the corresponding proton-spallation cross sections for targets and products in the elemental range $3 \leq Z \leq 8$, and we applied these cross sections to a cosmic-ray transport calculation wherein we investigated the sensitivity of the cosmic-ray L/M ratio [= (Li + Be + B) / (C + N + O)], and of the abundances of the L and M elements, to the helium fraction of the interstellar gas. (auth)

14194 NEW TEST OF TIME-REVERSAL INVARIANCE IN ^{19}Ne BETA DECAY. Calaprice, F.P.; Commins, E.D.; Girvin, D.C. (Physics Department and Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). Phys. Rev. D 9: No. 3, 519-529 (1 Feb 1974).

A new experimental upper limit on the "time-reversal" coefficient D is reported for the allowed beta decay $^{19}Ne \rightarrow {}^{19}F + e^+ + \nu_e$. The result, expressed in terms of the relative phase angle between axial-vector (A) and vector (V) couplings, is $\phi_{A,V}(^{19}Ne) = 180.2 \pm 0.4°$, consistent with T invariance. A nuclear-spin-polarized atomic beam of ^{19}Ne in which either of the magnetic substates $m_j = \pm 1/2$ can be selected, is allowed to terminate its flight in a cell, where the ^{19}Ne atoms remain for approximately four seconds without substantial spin depolarization. Delayed coincidences between positrons and ^{19}F-recoil ions from decays in the cell are observed and correlated with nuclear spin to determine D. The ^{19}Ne nuclear polarization is monitored continuously by observation of the beta-decay asymmetry. (auth)

14195 SYSTEMATICS OF "QUASIMOLECULAR" RESONANCES: A SEARCH FOR SUB-COULOMB RESONANT STRUCTURE IN THE REACTIONS $^{14}N + {}^{14}N$ AND $^9Be + {}^{12}C$. Hanson, D.L.; Stokstad, R.G.; Erb, K.A.; Olmer, C.; Sachs, M.W.; Bromley, D.A. (Wright Nuclear Structure Laboratory, Yale University, New Haven, Connecticut 06520). Phys. Rev. C 9: No. 5, 1760-1770 (May 1974).

A correlation between the absence of nonstatistical sub-Coulomb resonant structure in many reactions previously studied and the density of levels in the associated compound (or precompound) nucleus is noted and discussed in terms of the intermediate structure model of nuclear reactions. Such a correlation would predict the absence of structure in the $^{14}N + {}^{14}N$ system, in disagreement with a previous measurement of excitation functions for the production of γ radiation. Excitation functions for the reactions $^{14}N(^{14}N, p)^{27}Al$, $^{14}N(^{14}N, d)^{26}Al$, $^{14}N(^{14}N, \alpha)^{24}Mg$, $^9Be(^{12}C, \alpha)^{17}O$, and $^9Be(^{12}C, p)^{20}F$ have been measured in the region of the Coulomb barrier in a search for resonance structure of the "quasimolecular" type observed in $^{12}C + {}^{12}C$ scattering. The present measurements of excitation functions for charged-particle production in $^{14}N + {}^{14}N$ do not exhibit any correlated resonances. The $^9Be + {}^{12}C$ system at the Coulomb-barrier energy produces ^{21}Ne in a region of excitation where the level density is relatively low and hence could be a reaction in which intermediate structure might be observed. The excitation functions measured for α-particle production show fluctuations, but with no apparent correlations. (auth)

14196 ANALYZING POWERS FOR TWO-NUCLEON TRANSFER REACTIONS IN THE 1p SHELL. Macdonald, J.A.; Cerny, J.; Hardy, J.C.; Harney, H.L.; Bacher, A.D.; Plattner, G.R. (Department of Chemistry and Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). Phys. Rev. C 9: No. 5, 1694-1704 (May 1974).

The $(\vec{p}, t)$ and $(\vec{p}, {}^3He)$ reactions have been induced on ^{16}O, ^{15}N, and ^{13}C targets by polarized protons of 43.8 or 49.6 MeV. Relative differential cross sections and analyzing powers were measured for 32 transitions and compared with zero-range distorted-wave Born-approximation calculations employing Cohen and Kurath wave functions. Although good results for differential cross sections were obtained, attempts to fit analyzing powers were less successful. In general $(\vec{p}, t)$ results gave better agreement than $(\vec{p}, {}^3He)$, ground state transitions better than those to excited states, and transitions to analog states better than more complex transitions. (auth)

14197 MAGNETIC MOMENT OF THE 97-PS, $I^{\pi}=3^-$ LEVEL IN ^{14}C. Alexander, T.K.; Costa, G.J.; Forster, J.S.; Häusser, O.; McDonald, A.B.; Olin, A.; Witthuhn, W. (Chalk River Nuclear Laboratories, Atomic Energy of Canada Limited, Chalk River, Ontario, Canada KOJ 1JO). Phys. Rev. C 9: No. 5, 1748-1755 (May 1974).

The nuclear gyromagnetic ratio of the 6728-keV $I^{\pi} = 3^-$ level in ^{14}C has been determined by observation of the time-dependent intensity modulations caused by static, isotopic hyperfine fields occurring in hydrogen-like ^{14}C ions recoiling in vacuum. A value $|g| = 0.272 \pm 0.007$ is obtained. (auth)

14198 SEPARABLE POTENTIAL THREE-BODY MODEL OF THE A = 6 SYSTEM. I. ^6He GROUND STATE. Ghovanlou, A.; Lehman, D.R. (Department of Physics, The George Washington University, Washington, D.C. 20006). Phys. Rev. C 9: No. 5, 1730-1741 (May 1974).

Separable potential three-body (αnn) models of the ^6He ground state are investigated. Different separable-potential fits to the α-n phase shifts and the low-energy singlet two-nucleon parameters are discussed, after which integral equations are derived for the spectator functions of the ^6He ground-state wave function assuming $S_{1/2}$, $P_{1/2}$, and $P_{3/2}$ components in the α-n interaction. These equations are solved to determine the ^6He binding energy and examine its sensitivity to the two-nucleon singlet effective range, its variation upon neglecting different components of the α-n interaction, and its dependence on different analytic forms for the P-wave α-n interactions. The spectator functions for the "best" two sets of parameters are generated and tabulated, and for one set the contributions to the ground-state normalization of the various components in the ^6He ground-state wave function are computed. With the "best" $S_{1/2}$, $P_{1/2}$, and $P_{3/2}$ α-n interactions, the calculated ^6He binding energy is 0.542 MeV for a

two-nucleon s-wave separable potential fitted to the n-p $^1S_0$ effective-range parameters, $r_0 = 2.73$ fm, and $a = -23.715$ fm, and 0.359 MeV for the n-n $^1S_0$ effective-range parameters, $r_0 = 2.84$ fm, and $\alpha = -17$ fm, compared to the experimental value of 0.969 MeV. (auth)

14199 COULOMB CORRECTIONS TO NUCLEAR BETA DECAY THROUGH INDUCED TERMS. Bottino, A.; Ciocchetti, G. (Istituto di Fisica dell'Università, Torino, Italy); Kim, C.W. Phys. Rev. C 9: No. 5, 2052-2055 (May 1974).

We present an analytical expression for the shape factor for the β decay of ^{12}B with the Coulomb corrections to order αZRW_0, including the correction through the induced weak magnetism term and examine effects of this induced Coulomb correction. (auth)

14200 BOUND STATES OF THE MULTICHANNEL ($n\alpha\alpha$) SYSTEM. Chuu, D.S.; Han, C.S.; Lin, D.L. (Department of Physics and Astronomy, State University of New York, Buffalo, New York 14214). Phys. Rev. C 9: No. 5, 2086-2087 (May 1974).

The multichannel three-body model is applied to ($n\alpha\alpha$) system to study the bound states of ^9Be. The α particle involved in this system is assumed to be a two-level particle to take care of its internal structure. The energies of the ground state [(3/2)$^-$] and an excited state [(1/2)$^+$] are calculated to be -1.76 and +0.68 MeV, respectively. (auth)

14201 ELECTRON SCATTERING FROM EXCITED STATES IN ^{14}N AND ^9Be. Ensslin, N.; Bertozzi, W.; Kowalski, S.; Sargent, C.P.; Turchinetz, W.; Williamson, C.F. (Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139); Fivozinsky, S.P.; Lightbody, J.W. Jr.; Penner, S. Phys. Rev. C 9: No. 5, 1705-1717 (May 1974).

Electron scattering form factors have been measured for the first six excited states in ^{14}N and for the 2.429-MeV (5/2$^-$) level in ^9Be. The form factors for the lowest T = 1 level in ^{14}N along with the previously measured ground-state magnetic moment are used to specify the T=0 and T=1 wave functions for the mass-14 system assuming two p-shell valence particles in an LS-coupling basis. The amplitudes of the various configurations so derived are generally in poor agreement with previous determinations, although the present wave functions yield values of the lifetime of the first T=0 state in ^{14}N and of the ^{14}N ground-state quadrupole moment that are in excellent agreement with previous measurements. The present data are not sufficiently precise to allow a direct separation of the T=0 and T=1 components for the first four negative-parity excited states. However, for two of these states which are excited primarily by C1 transitions, a comparison of the radiative strengths determined in this experiment with previous lifetime measurements sets a lower limit of 2% for the T=1 admixture. (auth)

14202 COMPARISON OF THE STRUCTURE SEEN IN THE REACTIONS $^{16}O(^{16}O, \alpha)^{28}Si$ AND $^{20}Ne(^{12}C, \alpha)^{28}Si$. Cosman, E.R.; Sperduto, A.; Cormier, T.M.; Chin, T.N. (Physics Department and Laboratory for Nuclear Science, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139); Wegner, H.E. Phys. Rev. C 9: No. 5, 2046-2049 (May 1974).

Strongly selected states at high excitation energies in ^{28}Si are seen in both of the above reactions. In the $^{16}O(^{18}O,\alpha)^{28}Si$ case, the energy dependence of the strongest transitions seen suggests that it is related to entrance-channel structure. Large differences in selectivity of the two reactions further indicate a sensitivity to the intrinsic structures of the initial states. (auth)

14203 NEUTON TOTAL CROSS SECTIONS BETWEEN 20 AND 45 MeV. Bubb, I. F.; Bunker, S.; Jain, M.; Leonard, J. W.; Mellwain, A.; Roulston, K. I.; Standing, K. G.; Wells, D. O.; Whitmore, B. G. (Univ. of Manitoba, Winnipeg). Can. J. Phys.; 52: No. 7, 648-654(1 Apr 1974).

Neutron total cross sections were measured in the energy range of 20 to 45 MeV for Be, C, Al, Cu, and Zn. The typical accuracy was 1 to 2%. Results are compared with optical model calculations in which the only variable is the surface absorption strength, which is constrained to vary with a linear energy dependence. The calculation is extended to include 13 nuclei with A < 75. (auth)

14204 $^{12}C(e,e'p)$ RESULTS AS A CRITICAL TEST OF AN ENERGY SUM RULE. Bernheim, M.; Bussière, A.; Gillebert, A.; Mougey, J.; Ho, P.X.; Priou, M.; Royer, D.; Sick, I.; Wagner, G.J. (Centre d'Etudes Nucléaires de Saclay, 91190 Giff-sur-Yvette, France). Phys. Rev. Lett. 32: No. 16, 898-901 (22 Apr 1974).

The reaction $^{12}C(e,e'p)$ at 497 MeV in conjunction with a distorted-wave impulse-approximation analysis was used to determine kinetic and separation energies of bound protons. The spectral function for separation energies less than 74 MeV provides only half of the total binding energy; i.e., the data do not satisfy Koltun's sum rule. The momentum distributions are compatible with elastic electron scattering. (auth)

14205 CONTINUUM-SHELL-MODEL DESCRIPTION OF COMPOUND RESONANCES IN THE SYSTEM ^{16}O+n. George, J.; Philpott, R.J. (Department of Physics, The Florida State University, Tallahassee, Florida 32306). Phys. Rev. Lett. 32: No. 16, 901-904 (22 Apr 1974).

Bound and continuum properties of the system ^{16}O+n are obtained from a microscopic model by means of an extended R-matrix formalism. The model includes configurations arising from excitation description of up to four particles from the closed ^{16}O core and provides a useful dynamical description of the observed low-energy spectrum. (auth)

14206 ISOSCALAR ELECTRIC QUADRUPOLE STRENGTH IN ^{16}O. Snover, K.A.; Adelberger, E.G.; Brown, D.R. (Department of Physics, University of Washington, Seattle, Washington 98195). Phys. Rev. Lett. 32: No. 19, 1061-1063 (13 May 1974).

A detailed study of $^{12}C(\alpha, \gamma_0)^{16}O$ from $E_\alpha = 12$ to 28 MeV reveals a T = 0, E2 strength which constitutes $\simeq$ 17% of the sum rule in the α_0 channel alone. Together with other results, $\simeq$ 42% of this sum rule is accounted for in ^{16}O. We estimate that the inclusion of other channels would raise this total strength to $\sim$ 70% and give an E2 energy centroid and width both of $\sim$ 15 MeV. (auth)

14207 ELASTIC AND INELASTIC SCATTERING OF ^6Li ON ^{12}C. Bindal, P.K.; Nagatani, K. (Cyclotron Institute, Texas A&M University, College Station, Texas 77843); Schneider, M.; Bond, P. Phys. Rev. C 9: No. 6, 2154-2165 (June 1974).

Elastic and inelastic scattering of ^6Li on ^{12}C were studied at 36.4 MeV and 40.0 MeV incident energies. Previously published elastic scattering data for 20, 24.5, 28, 30.6, and 63 MeV incident energies as well as the present data were analyzed to obtain an energy-dependent optical potential. Inelastic scattering was measured for the transitions to the states at 4.44 MeV (2$^+$), 7.65 MeV (0$^+$), 9.63 MeV (3$^-$), 10.84 MeV (1$^-$), 11.83 MeV (2$^-$), 12.71 MeV (1$^+$), 13.35 MeV (2$^-$), and 14.05 MeV (4$^+$) in ^{12}C. The angular distributions were analyzed using the distorted wave Born approximation with the usual collective form factor. Various options for the form factors and the optical potentials were investigated. It is found that the use of complex form factors generally fits the data. Results of these calculations are presented for all transitions and the values of β are deduced. For the transition to the 4.44 MeV (2$^+$) state, both the shape and magnitude of the angular distribution (and hence the state's deformation parameter β_2) were well reproduced. (auth)

14208 QUASIELASTIC ELECTRON SCATTERING. Whitney, R.R.; Sick, I. (High Energy Physics Laboratory and Department of Physics, Stanford University, Stanford, California 94305); Ficenec, J.R.; Kephart, R.D.; Trower, W.P. Phys. Rev. C 9: No. 6, 2230-2235 (June 1974).

Data and interpretation are presented for inelastic electron scattering in the quasielastic region from nine target nuclei ranging from lithium to lead at an incident energy of 500 MeV and a scattering angle of 60°. The average kinetic and separation energies of nucleons in these nuclei are deduced. Results of and comments on the radiative correction procedures used in the data analysis are also discussed. (auth)

14209 PRODUCTION OF Li AND B IN PROTON AND ALPHA-PARTICLE REACTION ON ^{14}N AT LOW ENERGIES. Jacobs, W.W.; Bondansky, D.; Chamberlin, D.; Oberg, D.L. (Department of Physics, University of Washington, Seattle, Washington 98195). Phys. Rev. C 9: No. 6, 2134-2143 (June 1974).

Cross sections have been measured for the production of ^7Li and ^{11}B from the reactions $^{14}N(p, 2\alpha)^7Be$ and $^{14}N(p, \alpha)^{11}C$ from near threshold to 24 and 22 MeV, respectively, and for the production of ^6Li and ^{10}B in α-particle bombardment of ^{14}N up to 42 MeV. The proton reactions were studied with activation techniques and the α-particle reactions investigated using time-of-flight particle identification. These cross sections are of interest because of their relevance to the production of the light elements in nature by relatively low-energy particles. Analyses of comparative production cross sections from CNO targets indicate that it is possible to match the solar system abundances of LiBeB with reactions dominated by protons of energies below about 25 MeV, provided one accepts the higher of recent estimates of the B abundance. (auth)

14210 INTERPRETATION OF QUASIFREE SCATTERING IN THE ^6Li(p, pd) AND (p, p^{3}He) REACTIONS. Sakamoto, Y. (Institut für Kernphysik der Universtät Frankfurt am Main, Frankfurt am Main, Germany); Cüer, P.; Takéutchi, F. Phys. Rev. C 9: No. 6, 2440-2443 (June 1974).

The large difference between the cross sections for the quasifree scattering in the ^6Li(p, pd) and (p, p^{3}He) (p, pt) reactions are accounted for on the basis of separation energies. (auth)

14211 A = 9 ISOSPIN QUARTET. Kashy, E.; Benenson, W.; Nolen, J.A. Jr. (Cyclotron Laboratory, Department of Physics, Michigan State University, East Lansing, Michigan 48824). Phys. Rev. C 9: No. 6, 2102-2105 (June 1974).

New measurements of the mass excess of the lowest T=3/2 levels in ^9Be and ^9B give values of 25.7406$\pm$0.0017 and 27.0711$\pm$0.0023 MeV,

respectively, and indicate a definite cubic dependence for the masses of the A=9 quartet which includes ^{9}Li and ^{9}C in their ground states. A value of 7.6±1.7 keV is obtained for the coefficient of the T_z^3 term which now clearly exceeds the current theoretical estimates. Precise values of excitation energy of levels in ^{10}B and ^{11}B have been obtained as part of these measurements. (auth)

14212 T=3/2 STATES IN MASS-11 NUCLEI. Benenson, W.; Kashy, E.; Kong-A-Siou, D.H.; Moalem, A.; Nann, H. (Cyclotron Laboratory, Physics Department, Michigan State University, East Lansing, Michigan 48824). Phys. Rev. C 9: No. 6, 2130-2133 (June 1974).

A 740-keV-wide peak in the ^{4}He spectrum from the bombardment of ^{14}N by 70-MeV ^{3}He particles is identified as the mirror of the 1/2$^-$ first excited state of ^{11}Be. The Q value for the ^{14}N(^{3}He, ^{4}He)^{11}N reaction to this state is −25.03±0.10 MeV, which corresponds to a mass excess of 25.23±0.10 MeV. The analogs of this state in ^{11}C and ^{11}B were observed with the ^{13}C(p, t) and ^{13}C(p, ^{3}He) reactions, and the excitation energies and widths found to agree well with the previous measurements. (auth)

14213 ANGULAR DISTRIBUTION AND POLARIZATION OF ^{16}O(γ, n_0)^{15}O. Wang, W.L. (Carnegie-Mellon University, Pittsburgh, Pennsylvania 15213 and Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720); Shakin, C.M. Phys. Rev. C 9: No. 6, 2144-2153 (June 1974).

We report a detailed calculation of the angular distribution and polarization of the photoneutrons from ^{16}O in the giant dipole region. The electric dipole (E1) amplitudes are obtained from a continuum shell-model calculation which reproduces the intermediate structure in the total cross section. A consistent interpretation of the angular distribution and polarization may be obtained either by (i) assuming a phenomenological giant quadrupole (E2) resonance, or (ii) by modifying the phase difference between the E1 amplitudes. In case (ii), we do not require any E2 resonance to fit the data, or, alternatively, the magnitudes of the E2 amplitudes used can be taken to be in reasonable agreement with those extracted from the polarized-proton capture experiment. As we show in case (i), there is a theoretical possibility for an E2 resonance. On the other hand, the present experimental results indicate the absence of such a resonance in the dipole region; this possibility is studied in case (ii). (auth)

14214 ANOMALOUS POPULATION OF TWO 4$^+$ STATES IN ^{12}C(^{6}Li, d)^{16}O. Debevec, P.T.; Fortune, H.T. (Argonne National Laboratory, Argonne, Illinois 60439); Segel, R.E.; Tonn, J.F. Phys. Rev. C 9: No. 6, 2451-2453 (June 1974).

In the reaction ^{12}C(^{6}Li, d)^{16}O, two 4$^+$ states (at E_x = 10.35 and 11.096 MeV) are populated with relative strengths of $\sigma(11.096)/\sigma(10.35) \simeq 0.5$ even though their reduced α-particle widths to the g.s. of ^{12}C are in the ratio $S_\alpha(11.096)/S_\alpha(10.35) < 10^{-2}$. A two-step process proceeding through the first excited state of ^{12}C offers a likely mechanism of the enhanced feeding of the 11.096-MeV state. (auth)

14215 A THEORY OF INTERMEDIATE STRUCTURE, OVERLAPPING RESONANCES AND PHOTONUCLEAR REACTIONS IN LIGHT NUCLEI. Mustafa, M.G. (Physics Division, Oak Ridge National Laboratory, P.O. Box X, Oak Ridge, Tennessee 37830); Malik, F.B. Ann. Phys. (N.Y.) 83: No. 2, 340-354 (Apr 1974).

Starting from a many body Hamiltonian a general theory involving intermediate structures and overlapping resonances in nuclear reaction has been worked out. This treatment, based on Trefftz's work on dielectronic recombination in atomic physics, avoids explicit use of projection operators and all relevant quantities like decay widths and energy shifts are explicitly expressed in terms of two body matrix elements. In particular, attention has been focused on the interaction of bound states among themselves and then on the coupling of the continuum with these interacting bound states. For the case of overlapping resonances, it is shown that in general one cannot take a simple energy average of the resonant amplitudes, and explicit equations for this case have been obtained. This microscopic theory also provides a justification of the model of Duke, Malik, and Firk in explaining the intermediate structure in giant dipole resonance region of ^{16}O and ^{28}Si. However, the formalism is a general one and is suitable for the study of intermediate structure involving isolated and overlapping resonances for many types of reactions. (auth)

14216 HIGHLY PROTON-RICH T_z = −2 NUCLIDES: ^{8}C AND ^{20}Mg. Robertson, R.G.H. (Cyclotron Laboratory and Physics Department, Michigan State University, East Lansing, Michigan 48824); Martin, S.; Falk, W.R.; Ingham, D.; Djaloeis, A. Phys. Rev. Lett. 32: No. 21, 1207-1209 (27 May 1974).

Two nuclides with a proton excess of 4 have been produced via the (α, ^{3}He) reaction, and their masses measured. The mass excess of $^{8}_{6}$C is 35.30 ± 0.20 MeV, and ^{8}C is therefore unbound with a measured width of 220^{+80}_{-140} keV. The ^{8}C mass excess is 0.57 MeV is less than the Kelson-Garvey prediction. For $^{20}_{12}$Mg, a mass excess of 17.74 ± 0.21 MeV is found, indicating that ^{20}Mg is nucleon stable. Knowledge of the ^{20}Mg mass permits for the first time a test of the isobaric multiplet mass equation in an isobaric quintet, and good agreement is found. (auth)

14217 EFFECT OF EXPANSION OF THE SHELL MODEL SPACE ON THE STRUCTURE OF THE MASS-15 NUCLEI. Saayman, R.; De Kock, P. R. (Stellenbosch Univ., South Africa). Z. Phys.; 266: No. 2, 83-94(Jan 1974).

The structure of the natural and unnatural parity states of the ^{15}N-^{15}O mirror pair, as well as the T = ½ analog states of ^{15}C, is discussed in terms of shell model calculations with a modified surface delta two-body interaction. The inert core is recomposed from ^{4}He to ^{12}C and the configuration space is systematically expanded to allow for an increasing number of particle excitations from the 1p into the 2s-1d shell. The relative importance of the 2s ½, 1d ⅝ and 1d ³⁄₂ orbitals are evaluated. Some electromagnetic properties of levels are also calculated. (GE)

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Refer also to abstracts 13693, 13928, 14189, 14190, 14193, 14203, 14208, 14215, 14216, 14236, 14249, 14251, 14346, and 14363.

14218 (NP-20034) INVESTIGATION OF EXCITED STATES IN ^{32}S BY THE ^{31}P(p,γ)^{32}S REACTION. Viitasalo, M.; Forsblom, I. (Helsinki Univ. (Finland). Dept. of Physics). 15 Feb 1974. 22p. Dep. NTIS (US Sales Only) $4.25.

The ^{31}P(p,γ)^{32}S reaction was studied in the proton energy region 300 to 1420 keV by using Ge(Li) techniques. Gamma decay schemes of 16 resonances are proposed. The branching ratios of the resonance states and 23 bound states are presented. The spin of the E_x = 7116 keV level was found to be $J^\pi = 2^+$. In addition, the present results are compared with earlier ones. (2 figures, 3 tables) (auth)

14219 (NP-20042) PROPERTIES OF LEVELS IN ^{35}Cl STUDIED BY MEANS OF THE ^{32}S(α,pγ)^{35}Cl REACTION. Ingebretsen, F. (Oslo Univ. (Norway). Fysisk Institutt). 1972. 115p. Dep. NTIS (US Sales Only) $8.75.

The reaction ^{32}S(α,pγ)^{35}Cl has been used to measure properties of levels in ^{35}Cl below 6.40 MeV excitation. Fifteen new levels, not reported in the compilation of Endt and van der Leun, have been observed. Level energies, spins, mean lifetimes, gamma-ray branching ratios and gamma-ray multipole mixing ratios have been measured by angular correlations and Doppler shift techniques. Gamma-ray transition strengths have been deduced, and the parity of some levels has been found. The data have provided stringent tests of nuclear model calculations. The applicability of the angular correlation method has been studied in detail. It is shown that the statistical tensors which describe the alignment of a gamma emitting state must lie within physical limits which depend on the number of magnetic substates populated. A consequence of this is that any measured angular correlation can in principle be analyzed when statistical tensors are used as free parameters. Furthermore, it is shown that some angular correlation measurements can not distinguish between different a priori possible level spins. Some of these ambiguities can be resolved from the angular correlation of gamma-rays further down in a cascade. The positive-parity levels below 4 MeV excitation are found to constitute three bands. These are described in terms of the Nilsson model involving orbits 8, 11 and 9, where the rotational–particle coupling is taken into account. The model gives a good description of the level energies and the E2 transition strengths. The log ft values of positron decay from ^{35}Ar, the M1 transition strengths and the single proton stripping spectroscopic factors are in qualitative agreement with experiment. The main deficiency of the model as applied to ^{35}Cl is attributed to the overestimation of the orbit-9 hole component in the band built on the first excited ½$^+$ state. The existence of rotational modes of excitation of ^{35}Cl is somewhat surprising, because there is some evidence for vibrational structure in the even–even nuclei above ^{28}Si. However, the rotational model has also been applied to the T = ½ ^{33}P and ^{29}Si nuclei with some success and calculations along these lines can still be refined. (auth)

14220 SOME NEW FEATURES OF THE DECAY OF ^{37}S. Hill, J.C. (Department of Physics, Texas A&M University, College Station, Texas 77843). Phys. Rev. C 9: No. 4, 1453-1456 (Apr 1974).

The β decay of ^{37}S to levels in ^{37}Cl was investigated using Ge(Li) detectors and sources produced by the ^{36}S(n,γ)^{37}S reaction. In addition to γ rays at 3103.3 and 3740.4 keV observed previously, new γ rays at 906.3 and 4009.3 keV were seen depopulating a level whose energy

from the weighted average of the two depopulating cascades is 4009.5 keV. The above results are compared with the findings of previous decay and reaction experiments. (auth)

14221 CROSS SECTIONS FOR THE SPALLATION PRODUCTION OF ^{10}Be IN TARGETS OF N, Mg, AND Si AND THEIR ASTROPHYSICAL APPLICATIONS. Raisbeck, G.M.; Yiou, F. (Laboratoire René Bernas du Centre de Spectrométrie Nucléaire et de Spectrométrie de Masse, 91406 Orsay, France). Phys. Rev. C 9: No. 4, 1385-1395 (Apr 1974).

Using an isotope-separator technique, cross sections have been measured for the spallation production of ^{10}Be in targets of N, Si, and Mg by protons of 600 MeV and in N by protons of 150 MeV. For 600-MeV protons σ (^{10}Be) = 1.3 $\pm$ 0.6, 0.7 $\pm$ 0.3, and 1.3 $\pm$ 0.4 mb in N, Si, and Mg respectively. For 150-MeV protons σ (^{10}Be) = 0.6 $\pm$ 0.2 mb in N. The results are discussed in terms of the cosmogenic production of ^{10}Be in meteorites, lunar surface, cosmic dust, the earth's atmosphere, and the interstellar gas. It is shown that the Si and Mg components of chondritic material will be important sources of ^{10}Be, at least as far as the primary galactic flux is concerned. It is also pointed out that the quantitative evaluation of the ^{10}Be from lighter nuclei such as oxygen in meteorites and nitrogen in the earth's atmosphere depends strongly on the magnitude of the (unmeasured) secondary-neutron-induced reactions. ^{10}Be is shown to be a small fraction of the total Be formed in the spallation of cosmic rays over the whole range of important primary nuclei. Using standard radiochemical techniques cross sections have also been measured for ^{7}Be and ^{22}Na production in targets of Si and Mg irradiated by 600-MeV protons. The results differ significantly from previously published values. (auth)

14222 STUDY OF THE ^{10}B(^{16}O, α)^{22}Na REACTION. Gomez del Campo, J.; Ford, J.L.C. Jr.; Robinson, R.L.; Stelson, P.H. (Oak Ridge National Laboraotory, Oak Ridge, Tennessee); Thornton, S.T. Phys. Rev. C 9: No. 4, 1258-1272 (Apr 1974).

States in ^{22}Na were populated using the ^{10}B(^{16}O, α) reaction. Excitation functions were measured in the energy range $E_{c.m.}$ = 15.4 -17.7 MeV for 47 excited states in ^{22}Na from 0 to 14 MeV excitation. Angular distributions were measured at a bombarding energy of 46 MeV for a number of the excited states and were observed to be symmetrical around 90° (c.m.). Fluctuation analyses of the excitation functions were made, and the results indicated a statistical compound-nucleus process for the reaction mechanism. Hauser-Feshbach (H.F.) calculations gave good agreement with the data and provided strong evidence for proposed high-spin members of the ground-state rotational band, and the K = 0$^+$, T = 0 band in ^{22}Na. (auth)

14223 PHOTOPROTON CROSS SECTION OF ^{26}Mg. Anderson, D.W. (Department of Radiological Sciences, University of Oklahoma Health Sciences Center, Oklahoma City, Oklahoma 73104); Petry, R.F.; Fischbeck, H.J. Phys. Rev. C 9: No. 5, 1919-1923 (May 1974).

The cross section for the reaction ^{26}Mg(γ, p)^{25}Na has been measured from 15 to 60 MeV using bremsstrahlung activation methods to obtain the yield curve. The peak cross section of 15.7 mb occurs at 22.6 MeV. Prominent secondary maxima occur at 29.6, 49.0, and 57.9 MeV. The cross section integrated to 28 MeV is 80 $\pm$ 9 MeV mb. The cross section integrated to 60 MeV is 161 $\pm$ 18 MeV mb. A discussion of our results and comparison with photoneutron data for ^{26}Mg from other sources is given. (auth)

14224 ISOBARIC MASS QUARTETS IN A = 33 NUCLEI. Nann, H.; Benenson, W.; Kashy, E. (Cyclotron Laboratory and Department of Physics, Michigan State University, East Lansing, Michigan 48824); Turek, P. Phys. Rev. C 9: No. 5, 1848-1850 (May 1974).

The ^{36}Ar(^{3}He, ^{6}He)^{33}Ar reaction has been used to measure the mass excess of the ground state and of the first two excited states of ^{33}Ar. The coefficients of the isobaric-mass-multiplet equation are calculated for the three new isobaric spin quartets which are completed by the present results. (auth)

14225 UNBOUND STATES IN ^{29}Si WITH THE ^{28}Si(d, p) REACTION. Medsker, L.R.; Jackson, H.E.; Yntema, J.L. (Argonne National Laboratory, Argonne, Illinois 60439). Phys. Rev. C 9: No. 5, 1851-1856 (May 1974).

The unbound states up to 10.477-MeV excitation energy in ^{29}Si were studied with the ^{28}Si(d, p)^{29}Si reaction. Experimental angular distributions were analyzed by use of distorted-wave Born-approximation calculations according to the Vincent-Fortune method, and neutron resonance widths were calculated from the measured cross sections of each state for the possible neutron single-particle assignments $2p_{3/2}$, $1d_{3/2}$, and $1f_{7/2}$. Several l values were determined by comparing the neutron widths extracted from the (d, p) data with neutron widths previously measured in the (n, γ) and (n, total) experiments. (auth)

14226 DECAY OF THE 22-μs ISOMERIC STATE OF ^{38}K. Yates, S.W.; Lynch, F.J.; Holland, R.E.; Ahmad, I.; Friedman, A.M. (Argonne National Laboratory, Argonne, Illinois 60439). Phys. Rev. C 9: No. 5, 1857-1860 (May 1974).

The decay of the 22.5-μs isomer of ^{38}K has been studied by observing the delayed γ rays following the ^{24}Mg(^{16}O, pn)^{38}K and ^{35}Cl(α, n)^{38}K reactions. γ-ray singles and γ-γ coincidence measurements were made and the reaction threshold for production of the isomer was determined for the (α, n) reaction. The 3458-keV metastable state decays by an apparent E1 transition (α_T = 0.58) to a level at 3420 keV and by an 812-keV transition to a level at 2646 keV. The isomerism is understood in terms of the selection rules for the decay of E1 transitions in T = 0 nuclei. A weak-coupling estimate of the excitation energy of the 7$^+$($1f_{7/2}$)^2 state in ^{38}K yields a value in excellent agreement with that observed for this isomer. (auth)

14227 HIGH-MOMENTUM-TRANSFER ELECTRON SCATTERING FROM ^{24}Mg, ^{27}Al, ^{28}Si, AND ^{32}S. Li, G.C.; Yearian, M.R. (High Energy Physics Laboratory and Department of Physics, Stanford University, Stanford, California 94305); Sick, I. Phys. Rev. C 9: No. 5, 1861-1877 (May 1974).

High-momentum-transfer elastic electron scattering data (0.76 $\leq$ q $\leq$ 3.74 fm^{-1}) from ^{24}Mg, ^{27}Al, ^{28}Si, and ^{32}S are presented and analyzed using phenomenological charge distributions; the oscillation in ρ(r) due to the shell-model structure is obtained. An analysis in terms of a Woods-Saxon nuclear potential is described and the 2s/1d occupation numbers are deduced. The cross sections for certain strongly excited or well isolated inelastic levels are also given, but not analyzed. (auth)

14228 EXCITATION OF ^{32}S AND ^{56}Fe BY INELASTIC SCATTERING OF 14.1 MeV NEUTRONS. Adam, A.; Deak, F.; Kecskemeti, J.; Koncz, P.; Palla, G. (Central Research Inst. for Physics, Budapest). Acta Phys. Acad. Sci. Hung.; 35: No. 1-4, 85-89(1974).

Differential cross sections for the inelastic scattering of 14.1-MeV neutrons to the 2.24-MeV state of ^{32}S and the 0.845 MeV state of ^{56}Fe were measured and compared with coupled-channel calculations. They are in reasonable agreement. The deformation parameters β_2 are quite similar to the electromagnetic values. (auth)

14229 E_p = 1.118-MeV RESONANCE IN THE ^{27}Al(p, γ)^{28}Si REACTION. Dalmas, J.; Leccia, F.; Aléonard, M.M. (Centre d'Etudes Nucléaires de Bordeaux-Gradignan, 33170 Gradignan, France). Phys. Rev. C 9: No. 6, 2200-2209 (June 1974).

The 12.664-MeV level in ^{28}Si has been populated by resonant proton capture at 1.118 MeV in the ^{27}Al(p, γ)^{28}Si reaction. γ-ray angular distributions have been measured with a 80-cm^3 Ge(Li) detector. The spin of the 11.432-MeV level is most probably 4 with T = 0; for the 8.413-MeV level, the assignment J$^\pi$ = 4$^-$ is in agreement with the present data. Mixing ratios for γ-ray transitions have been extracted from the angular distributions. Lifetime and branching-ratio studies have been made at E_p = 1.118, 1.724, and 2.876 MeV. Emphasis was given to measurements on levels at 8.413, 9.702, and 11.577 MeV, as possible candidates for the 4$^-$, 5$^-$, and 6$^-$ states of a K$^\pi$ = 3$^-$ rotational band based on the 6.879-MeV level. The observed E2 transition strengths are not in agreement with the above assumption. A strength of 0.3 Weisskopf units is found for the 12.664 $\rightarrow$ 8.413 MeV, M1 transition, which is in conformity with a J$^\pi$ $\rightarrow$ J$^\pi$, ΔT = 1 transition in a self-conjugate nucleus; this result may suggest the possibility of another interpretation of these negative-parity states, relied on one-particle-one-hole configurations. (auth)

14230 NUCLEAR-STRUCTURE CALCULATIONS WITH THE MODIFIED YALE POTENTIAL FOR THE 2s-1d SHELL. Mpanias, P.; Rustgi, M.L. (Nuclear Physics Laboratory, Department of Physics, State University of New York, Buffalo, New York 14214). Phys. Rev. C 9: No. 6, 2261-2271 (June 1974).

Employing the unitary-model approach of Shakin, Waghmare, Tomaselli, and Hull, and a modified version of the Yale potential, adjusted to yield a lower percentage of the "D" state in the deuteron ground state without affecting the other two-nucleon quantities calculable from the Yale potential, the ground-state properties of the even-even N = Z nuclei are calculated for the 2s-1d shell by using the Hartree-Fock self-consistent approach. The healing distance for the relative $^3S_1$ state is not used as a parameter since healing is "naturally" achieved for this state. Using the same values of the oscillator and level-shift parameters, the modified Yale interaction with its reduced tensor force component yields binding energies, single-particle energies, rms radii, and deformations which are generally closer to the experimental values than those reported for the Yale potential. (auth)

14231 DECAY SCHEMES OF ^{30}Al, ^{30}P, AND ^{20}O. Alburger, D.E.; Goosman, D.R. (Brookhaven National Laboratory, Upton, New York 11973). Phys. Rev. C 9: No. 6, 2236-2242 (June 1974).

^{30}Al was produced in the ^{18}O(^{18}O, αpn)^{30}Al reaction by bombarding a $Ta_2{}^{18}O_5$ target with 42-MeV ^{18}O ions. Following transfer of the target in a shuttle system the γ-ray spectrum was measured in a Ge(Li) detector. Nine γ-ray transitions were observed in ^{30}Si and have been fitted to an ^{30}Al decay scheme that includes five β-ray branches to excited states of ^{30}Si. The half-life of ^{30}Al is 3.685 $\pm$ 0.32 sec. ^{30}P was formed in the ^{30}Si(p, n)^{30}P reaction and a value of 2.499 $\pm$ 0.008 min

was obtained for its half-life. The β^+ branching of ^{30}P to the 2235-keV first excited state of ^{30}Si was found to be (0.061 ± 0.006) %, differing from previous results. ^{20}O, formed in the ^{16}O(^{18}O, ^{14}O)^{20}O reaction, was also studied and upper limits were placed on various β-decay branches. The half-life of ^{20}O was measured as 13.49 ± 0.05 sec. ft values for the β decay of ^{30}Al , ^{30}P, and ^{20}O are compared with recent theoretical calculations. (auth)

14232 SCATTERING OF 9.0-MeV NEUTRONS BY Al, Si, Fe, Ni, AND Co. Veikley, D.E.; Glasgow, D.W.; Brandenberger, J.D.; McEllistrem, M.T.; Manthuruthil, J.C.; Poirier, C.P. (Aerospace Research Laboratories, Wright-Patterson Air Force Base, Ohio 45433). Phys. Rev. C 9: No. 6, 2181-2192 (June 1974).

Measurements have been made of the differential elastic and inelastic scattering cross sections for 9.0-MeV neutrons scattered by Al, Si, Fe, Ni, and Co. These measurements were made on natural samples using a time-of-flight spectrometer with a shielded and biased liquid organic scintillator and pulse-shape discrimination. Corrections for finite geometry were made to all data using both analytical and Monte Carlo methods. Relative uncertainties in the measured cross sections are typically 2–3% and normalization uncertainties are 3–4%. Optical-model parameters were determined by fitting the elastic data. These parameters were used to determine the (N–Z)/A dependence of the real potential strength near A = 60 and to compare inelastic cross sections calculated using an incoherent sum of statistical-model and direct interaction contributions to the measured inelastic cross sections. (auth)

14233 ^{27}Si AND THE EXCITED CORE MODEL. Rios, M. (Univ. of Maryland, College Park). Particles Nucl.; 7: No. 1-2, 1-21(1974).

Electromagnetic properties of the first six excited states of ^{27}Si were investigated using the ^{28}Si(^{3}He,$\alpha\gamma$)^{27}Si reaction. The branching ratios of the levels at 0.956, 2.164, 2.647, 2.864 and 2.909 MeV were measured. Method II of Litherland and Ferguson was used in $\alpha-\gamma$ angular correlation studies of the levels at 0.781, 0.956 and 2.647 MeV. Spin assignments of J = 3/2 and J = 1/2 for the levels at 0.956 MeV and 2.647 MeV, respectively, are consistent with previous studies. Results are compared with excited-core model calculations. (auth)

Nuclear Properties and Reactions, 39 ≤ A ≤ 58

Refer also to abstracts 13240, 13693, 14208, 14228, 14230, 14232, 14260, 14266, 14268, 14280, 14311, 14317, 14346, 14358–14360, and 14363.

14234 (JINR-P4-7820) THEORY ON TRANSVERSE INELASTIC NEUTRON SCATTERING IN TRANSITION METALS. Kuzemskii, A. L. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 18p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

A qualitative analysis of the transverse neutron inelastic cross section for the Hubbard model with s–d hybridization is performed in the framework of RPA. The poles of the transverse generalized spin susceptibility are studied. It is found that the acoustic spin wave pole exists among the set of poles of dynamical spin susceptibility and that noninteracting susceptibility determines the four quasi-Stoner continuum. (auth)

14235 (NP-20035) ENERGY LEVELS OF ^{54}Mn. Weckstroem, T.; Fant, B.; Forsblom, I.; Viitasalo, M. (Helsinki Univ. (Finland). Dept. of Physics). 28 Feb 1974. 22p. Dep. NTIS (US Sales Only) $4.25.

Two hundred and sixty-nine resonances of the ^{53}Cr(p, γ)^{54}Mn reaction in the proton range E_p = 1180 to 2100 keV were observed. The gamma decay of thirty-nine resonances was investigated by means of an 80-cm^3 Ge(Li) detector, and the energies and branching ratios of fifty-five bound states were determined. The Q value of the reaction was found to be 7559.6 ± 1.0 keV. (auth)

14236 INTRASHELL QUARTET EXCITED STATES. Dhar, A. K.; Kulkarni, D. R.; Bhatt, K. H. (Physical Research Lab., Ahmedabad, India). Pramana; 2: No. 2, 84-106(Feb 1974).

The intrashell quartet states are obtained by exciting two protons and two neutrons from the highest occupied orbital to the lowest unoccupied orbital of the lowest Hartree-Fock solutions for some even-even (N = Z) nuclei in the ds and fp shells. These intrinsic quartet states are found to be very high in energy. The states with good angular momenta are obtained by diagonalizing the Hamiltonian matrix constructed in the basis of the states projected from the lowest prolate and oblate HF states and the quartet excited intrinsic states with proper care of the non-orthogonality of these states. It was observed that for ^{20}Ne both the projection as well as the orthogonalization procedures significantly change the energy separations of the original intrinsic states and the low lying excited states do not have a well defined quartet structure. The excited states of ^{24}Mg and ^{28}Si which seem to have dominant quartet structure lie very high up in energy. In contrast to these nuclei, quartet excited states are not likely to provide a reasonable description of the eigenstates of the fp shell nuclei ^{44}Ti, ^{48}Cr and ^{52}Fe. (auth)

14237 PAIR CORRELATIONS AND COLLECTIVE 0^+ STATES IN NUCLEI WITH A ~ 56. Dzholos, R. V.; Kartavenko, V. G. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 19: No. 5, 964-970(May 1974). (In Russian).

Properties of the collective "pair" 0^+ states are investigated for nuclei with A = 48 to 64 in framework of a model taking into account only the isoinvariant pair residual forces. Indications are that for a correct description of such states it is necessary to account for not only the pair forces, but also the one-particle symmetry potential and the α-particle correlations. (auth)

14238 ISOSPIN DEPENDENCE OF THE OPTICAL POTENTIAL FROM ANALYSIS OF ELASTIC NEUTRON SCATTERING BY SEPARATED ISOTOPES. Tutubalin, A. I.; Klyucharev, A. P.; Golovnya, V. Ya.; Kachan, A. S. (Physical-Technical Inst., Kazan). Yadern. Fiz.; 19: No. 5, 959-963(May 1974). (In Russian).

The isospin dependence of the optical potential is investigated. The optimal values of the potential parameters are obtained analyzing the differential cross sections of elastic scattering of neutrons with energy 14.7 MeV by separated isotopes ^{54,56}Fe, ^{58,60}Ni and ^{59}Co based on a reformulated optical nuclear model. Data of other authors were used in the investigation. Strong dependence of depths of the real part of the potential and of the volume integrals on the neutron excess parameter α = (N–Z)/A is shown. (auth)

14239 GAMMA-RAY SPECTROSCOPY STUDIES OF ^{52}Ti. Pronko, J.G.; Bardin, T.T.; Becker, J.A.; Fisher, T.R.; McDonald, R.E.; Poletti, A.R. (Lockheed Palo Alto Research Laboratory, Palo Alto, California 94304). Phys. Rev. C 9: No. 4, 1430-1435 (Apr 1974).

Nuclear properties of the excited states of ^{52}Ti were measured using the ^{50}Ti(t, pγ) reaction at a bombarding energy of E_t = 2.9 MeV. Angular correlations of γ rays were obtained using an array of five NaI(Tl) counters in time coincidence with an annular particle detector positioned near 180°. Unique spin assignments for some of the excited states were obtained in addition to multipole-mixing-ratio and branching-ratio information. Nuclear lifetimes were measured using the Doppler-shift-attenuation method. Some of the measured excitation energies, spins, and mean lifetimes [E_x (keV), J, and τ (psec)], respectively, are as follows: (1047.1 ± 0.3, 2, $4.8^{+8.0}_{-4.1}$); (2259.4 ± 0.6, 2, $0.05^{+0.03}_{-0.02}$); (2427.9 ± 1.5, 2, ≤0.1); and (3582.5 ± 2.0, ≥1, ≤0.09). (auth)

14240 LIFETIME MEASUREMENTS IN ^{45}Sc. Schulte, R.L.; King, J.D.; Taylor, H.W. (Department of Physics, University of Toronto, Toronto, Canada). Phys. Rev. C 9: No. 4, 1436-1439 (Apr 1974).

The lifetimes of levels in ^{45}Sc have been determined by the Doppler-shift-attenuation method with the ^{44}Ca(p, γ)^{45}Sc reaction for 11 levels between 1.4 and 3.8 MeV. The energies (keV) of the levels and mean lives (psec) studied in this work are: 1408(<0.12); 1800(0.095); 2092(0.012); 2151(0.087); 2303(0.080); 2352(0.060); 2531(0.12); 2590(0.050); 2778(0.019); 2895(0.010); 3714(0.019). On the basis of E2 transition strengths the spin assignment of 5/2 has been determined for the 2092-keV state and further restrictions have been made to the range of possible spins for a number of states. (auth)

14241 ABSOLUTE CROSS SECTIONS FOR THE ^{58,60}Ni(^{16}O,X) REACTIONS. Robinson, R.L.; Kim, H.J.; Ford, J.L.C. Jr. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). Phys. Rev. C 9: No. 4, 1402-1417 (Apr 1974).

The absolute cross sections for a variety of reactions resulting from bombardment of ^{58,60}Ni with 38-, 42-, and 46-MeV ^{16}O ions were determined from yields of γ rays observed from the decay of resulting radioactivities and from yields of in-beam γ rays. The strongest reactions are (^{16}O,pn), (^{16}O,2p), and (^{16}O,αp). Other identified reactions are (^{16}O,p), (^{16}O,2n), (^{16}O,α), (^{16}O,αn), (^{16}O,2α), (^{16}O,2pn), (^{16}O,3p), (^{16}O,^{12}C), and (^{16}O,^{13}Ni). At the higher projectile energies the total cross sections are in reasonable agreement with the reaction cross sections based on an optical-model calculation. The relative yields of the reaction products were compared to predictions for statistical decay of a compound-nuclear system by neutron, proton, and α-particle emission. This model does account for the general features of the experimental data; in particular it correctly predicts that charged-particle emission strongly competes with neutron emission. (auth)

14242 GAMMA-RAY TRANSITIONS IN ^{50}V. Rickel, D.G.; McCullen, J.D. (Department of Physics, University of Arizona, Tucson, Arizona 85721). Phys. Rev. C 9: No. 4, 1446-1452 (Apr 1974).

γ-ray transitions from states in ^{50}V up to 1680 keV excitation have been studied using the (p, nγ) reaction. Branching ratios and some lifetime information were obtained. There is an indication of a doublet at 910 keV, the existence of which is previously unreported. Relative transition probabilities are compared to the $1f_{\frac{5}{2}}$ model of ^{50}V. (auth)

14243 RADIATIVE PROTON CAPTURE STUDY OF THE GIANT DIPOLE RESONANCE IN ^{55,57}Co. Maher, J.V.; Meyer-Schützmeister, L. (Argonne National Laboratory, Argonne, Illinois 60439); Sprenkel-Segel, E.L.; von Ehrenstein, D.; Nemanich, R.J.; Kiang, G.C.; Tonn, J.F.; Segel, R.E. Phys. Rev. C 9: No. 4, 1440-1445 (Apr 1974).

Extensive yield-curve and angular-distribution measurements have been made for the ^{54}Fe(p, γ_0) and the ^{56}Fe(p, γ_0) reactions. Both yield curves clearly show the envelope of the giant dipole resonance. The giant resonance appears to be broader in ^{57}Co and this is attributed to a greater isospin splitting and to the fact that proton emission from the two isospin components is expected to be more nearly equal. In both cases the angular distributions appear to be somewhat different for the two T components with the difference greater in ^{57}Co. (auth)

14244 NEUTRON-RICH ARGON NUCLEI. Gloeckner, D.H.; Lawson, R.D.; Serduke, F.J.D. (Argonne National Laboratory, Argonne, Illinois 60439). Phys. Rev. C 9: No. 5, 2071-2073 (May 1974).

It is shown that the $(\pi d_{3/2})^{-2}$ $(\nu f_{7/2}, \nu p_{3/2})^n$ model previously used to interpret the data on the lighter argon nuclei can be used to understand the recently observed results in $^{42}_{18}Ar_{24}$ and $^{44}_{18}Ar_{26}$. The first excited state of $^{44}_{18}Ar_{26}$ is predicted to be a core-excited 0^+ level arising from the configuration $[(d_{3/2})^{-4}_{00} \times (f_{7/2})^8_{04}]_{J=0,T=4}$. (auth)

14245 PHOTONUCLEAR REACTIONS IN ^{40}Ca. Brajnik, D.; Jamnik, D.; Kernel, G.; Miklavžič, U.; Stanovnik, A. (J. Stefan Institute, University of Ljubljana, Ljubljana, Yugoslavia). Phys. Rev. C 9: No. 5, 1901-1918 (May 1974).

Natural calcium targets were bombarded with γ rays from a 31-MeV betatron at several bremsstrahlung end-point energies. Angular and energy distributions of photoprotons were measured. In addition, the γ-ray spectra emerging from the thick target were recorded at several angles. They were used to study the γ rays accompanying the decay of excited residual nuclei formed in the reactions ^{40}Ca(γ, p) and ^{40}Ca(γ, n). The analysis yielded the following results for the main reaction channels: the energy dependence of the cross sections, the energy dependence of photoproton angular distributions, and the bremsstrahlung-weighted angular distributions of deexcitation γ rays. According to the experimental results the following amplitudes seem to dominate in the particle channels: $f_{5/2}$ waves for the (γ, p_0) reaction, $p_{3/2}$ waves for (γ, p_1), and p waves for reaction channels in which the residual nuclei are left in states above 4.93 MeV. This is consistent with the giant dipole state configuration, predicted on the basis of the shell-model bound-state calculation by Gillet and Sanderson. The agreement with continuum theories is less satisfactory. It is also found that the shapes of cross sections are more uniform and that the angular distributions are less energy-dependent than expected from theory. The (γ, p_1) cross section was separated into S = 0 and S = 1 channel spin contributions of which only the dominant S = 0 part shows a resonant structure. Negative-parity hole channels bear evidence for two-step reaction processes and impurities in the ground state of ^{40}Ca. Ratios of (γ, p) and (γ, n) cross sections imply an admixture of less than 3% of T = 0 strength in the ^{40}Ca giant dipole resonance. (auth)

14246 MASSES FOR ^{43}Ar AND THE NEW ISOTOPES ^{43}Ar AND ^{44}Ar. Jelley, N.A.; Wilcox, K.H.; Weisenmiller, R.B.; Wozniak, G.J.; Cerny, J. (Department of Chemistry and Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). Phys. Rev. C 9: No. 5, 2067-2070 (May 1974).

The reactions (α, ^{9}Be), (α, ^{7}Be), and (^{6}Li, ^{8}B) on ^{40}Ca at E(α) = 78 MeV and E(^{6}Li) = 80 MeV were used to determine the mass excesses of ^{43}Ar(-31.98 ± 0.07 MeV), ^{43}Ar(-29.727 ± 0.06 MeV), and ^{44}Ar(-29.732 ± 0.07 MeV) by counter telescope techniques. Excited states in ^{43}Ar at 1.74 ± 0.05, 2.55 ± 0.05, 3.56 ± 0.07, and 4.74 ± 0.10 MeV and in ^{43}Ar at 1.66 ± 0.05, 2.42 ± 0.05, and 3.25 ± 0.07 MeV were also observed. Comparisons are made with mass predictions calculated from simple mass relations based on the shell model and with those obtained from the Garvey and Kelson approach. (auth)

14247 ^{44}Ca(d, α)^{42}K REACTION AT 4.0 MeV. Lee, S. T.; Long, D. D. (Virginia Polytechnic Inst. and State Univ., Blacksburg). Can. J. Phys.; 52: No. 9, 772-778(1 May 1974).

The angular distributions from the ^{44}Ca(d, α)^{42}K reaction were measured at E_d = 4.0 MeV in a range of angles from 40 to 160°. Based on the observation of forward peaking of the angular distributions and diminished fluctuations at 4 MeV in the excitation function, an analysis was carried out utilizing the distorted wave Born approximation. For the five strongly excited levels below 1.3 MeV, satisfactory fits were obtained using optical model parameters from the literature. The results, which were consistent with the spin assignments from other experiments, revealed no gross inadequacies of a direct reaction analysis at this energy which are not present at higher energies. For three levels in ^{42}K, the range of spins was tentatively reduced. In the case of the 1.113 MeV level, no previous assignments had been made. (auth)

14248 L DEPENDENCE IN ANGULAR DISTRIBUTIONS OF THE TWO-PROTON TRANSFER REACTION ^{48}Ca(^{16}O, ^{14}C)^{50}Ti. Henning, W.; Kovar, D.G.; Zeidman, B.; Erskine, J.R. (Argonne National Laboratory, Argonne, Illinois 60439). Phys. Rev. Lett. 32: No. 18, 1015-1019 (6 May 1974).

The reaction ^{48}Ca(^{16}O, ^{14}C)^{50}Ti to the lowest 0^+, 2^+, 4^+, and 6^+ states of ^{50}Ti has been studied at 56 MeV. Rapid oscillations in the angular distribution persist to extreme forward angles (θ_L = 3°). In the present data, the forward-angle structure is found to be an unambiguous indicator of the transferred angular momentum. The data are reproduced by distorted-wave Born-approximation calculations. A qualitative understanding is obtained in the strong-absorption model. It is believed that such behavior will occur in many heavy-ion-induced transfer reactions. (auth)

14249 HALF-LIVES OF NINE RADIOISOTOPES. Rothman, S.J.; Peterson, N.L.; Chen, W.K.; Hines, J.J.; Bastar, R.; Robinson, L.C.; Nowicki, L.J.; Anderson, J.B. (Materials Science Division, Argonne National Laboratory, Argonne, Illinois 60439). Phys. Rev. C 9: No. 6, 2272-2274 (June 1974).

We have determined the half-lives of nuclides ^{28}Mg, ^{52}Fe, ^{55}Co, ^{57}Ni, ^{67}Cu, ^{69}Zn^m, ^{112}Pd, ^{105}Ag, and ^{111}Ag. The decay was followed for more than 10 half-lives in most cases. The long duration of the measurements, the stability of the counting equipment, and computer programs that allowed least-squares fitting to the sum of several exponentials yielded highly accurate values of the half-lives. (auth)

Nuclear Properties and Reactions, 59 ≤ A ≤ 89

Refer also to abstracts 13693, 14203, 14208, 14232, 14237, 14238, 14241, 14249, 14268, 14280, 14286, and 14363.

14250 (INIS-mf-1246) NUCLEAR STRUCTURE CALCULATIONS FOR ^{88}Sr, ^{89}Y, AND ^{90}Zr. Lettinck, P. (Vrije Universiteit, Amsterdam (Netherlands)). 20 Sep 1973. 89p. INIS.

Some shell model calculations for the nuclei ^{88}Sr, ^{89}Y and ^{90}Zr are presented. The particle-hole model is applied to the description of the properties (energy levels, wave functions, electromagnetic properties and spectroscopic factors) of the three nuclei. All neutrons are assumed to form a closed shell core and only proton p-h excitation is included from the four single-particle orbits $1f_{\frac{5}{2}}$, $2p_{\frac{3}{2}}$, $2p_{\frac{1}{2}}$ and $1g_{\frac{9}{2}}$. As residual interaction two different phenomenological interactions were taken, namely the surface delta interaction and an interaction with Gaussian radial dependence and a Serber exchange mixture. The p-h calculations are compared with low-seniority calculations. From this comparison it is concluded that the excitation of identical nucleons coupled to angular momentum zero in the same single-particle orbit is more important than the breaking of this kind of pairs for the low-lying levels. The low-lying levels of an odd nucleus are described by taking the levels of the neighboring even-even nucleus and coupling to these levels the odd particle in several single-particle orbits. Some comments have been made about a few calculations of the three nuclei which have appeared in literature with other types of models. (8 figures, 20 tables) (INIS)

14251 RATIO OF THE PHOTO- AND ELECTRO-DISINTEGRATION CROSS SECTIONS OF NUCLEI AT HIGH ENERGIES. Noga, V. I.; Ranyuk, Yu. N.; Sorokin, P. V. (Physical-Technical Inst., Kazan). Yadern. Fiz.; 19: No. 5, 945-948(May 1974). (In Russian).

Using the induced activity method the ratio is studied of the photo- and electro-disintegration cross sections of nuclei for the reactions ^{27}Al → ^{24}Na and ^{63}, ^{65}Cu → ^{58}Co in the energy interval 300 to 1200 MeV. The measured results are compared with the calculations at various assumptions on the virtual and real photon spectra. (auth)

14252 MULTIPOLE MIXING RATIOS IN ^{77}Se FROM γγ DIRECTIONAL CORRELATIONS FOLLOWING 56-h ^{77}Br DECAY. Braga, R.A.; Sarantites, D.G. (Chemistry Department, Washington University, St. Louis, Missouri 63130). Phys. Rev. C 9: No. 4, 1493-1505 (Apr 1974).

The decay properties of the levels in ^{77}Se were investigated following the decay of 56-h ^{77}Br. Singles γ-ray energy and intensity measurements were obtained with a 42-cm^3 high-resolution Ge(Li) γ-ray detector in an anti-Compton arrangement employing a large NaI(Tl)

annular detector. Extensive $\gamma\gamma$-coincidence and directional correlation measurements were obtained with two large Ge(Li) detectors. An improved decay scheme was contructed. From $\gamma\gamma$ correlation measurements, deduced logft values, and internal-conversion coefficients, the J^π values in parentheses for the following levels in keV were confirmed: g.s. ($1/2^-$), 161.83($7/2^+$), 238.98($3/2^-$), 249.65($5/2^-$), 439.42($5/2^-$), 520,59($3/2^-$), 817.78($1/2^-$), and 1005.08($3/2^-$); and further J^π assignments in parentheses for the following levels are proposed: 300.78($5/2^+$), 580.90($5/2^+$), 679.7($5/2^+$), 824.35($3/2^-$, $5/2^-$), 911.40($3/2^+$), 1186.55($3/2^-$), and 1230.62($3/2^+$, $5/2^-$). With the 249.77- and 439.47-keV transitions assumed to be pure E2, the mixing ratio δ (M2/E1) = -0.09 ± 0.05 was obtained for the 87.59-keV transition, while the δ (E2/M1) mixing ratios obtained were: 200.40 keV, 0.00 ± 0.09; 238.98 keV, 0.13 ± 0.04; 270.83 keV, $0.30^{+0.05}_{-0.06}$; 281.65 keV, $-0.12^{+0.03}_{-0.04}$; 297.23 keV, 0.17 ± 0.03 or -2.7 ± 0.2 303.76 keV, $-0.44^{+0.03}_{-0.16}$ or $0.09^{+0.05}_{-0.04}$; 384.99 keV, $-0.23^{+0.07}_{-0.05}$; 484.57 keV, $-0.27^{+0.04}_{-0.03}$; 520.69 keV, $0.17^{+0.06}_{-0.07}$; 574.64 keV, 0.23 ± 0.06 for $3/2^- \rightarrow 5/2^-$ or $-0.31^{+0.07}_{-0.08}$ for $5/2^- \rightarrow 5/2^-$; 578.91 keV, $0.16^{+0.02}_{-0.04}$ or $-2.6^{+0.2}_{-0.3}$; and 755.35 keV, $0.31^{+0.09}_{-0.08}$. From these multipole mixing ratios, present branching ratios and previously measured lifetimes improved and new values of reduced transition probabilities were calculated for the transitions at 87.59, 200,40, 238.98, 249.77, 270,83, 277.47, 281.65, 439.47, and 520.60 keV. The results of this study are compared with previous work and the structure of the lower levels in ^{77}Se is discussed in terms of recent theoretical models for nuclear structure. (auth)

14253 LEVELS OF ^{84}Se FROM THE ^{82}Se(t, p)^{84}Se REACTION. Knight, J.D.; Orth, C.J.; Leland, W.T. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87544); Tucker, A.B. Phys. Rev. C 9: No. 4, 1467-1473 (Apr 1974).

The levels of ^{84}Se have been investigated by the ^{82}Se(t, p) reaction with 15-MeV tritons. Proton spectra were recorded with a semiconductor counter telescope at lab angles between 12.5 and 90°. Differential cross sections were measured for 19 levels up to 5.633 MeV and compared with distorted-wave Born-approximation angular distributions. The first excited state in ^{84}Se occurs at 1.455 MeV. Excited 0^+ states were observed at 2.247 and 2.655 MeV, with cross sections equal to that for the ground state. The two-neutron separation energy of ^{84}Se was determined to be $S_{2n} = 14.498 \pm 0.015$ MeV. Eight excited states of ^{82}Se were observed by the ^{80}Se(t, p) reaction. (auth)

14254 STUDY OF EXCITED STATES OF ^{75}As WITH THE ^{74}Ge(p,γ)^{75}As REACTION. Wang, C.W.; Liu, Y.C.; Lin, E.K.; Hsu, C.C.; Kiang, G.C. (Tsing Hua University and Academia Sinica, Taiwan, China). Phys. Rev. C 9: No. 4, 1396-1401 (Apr 1974).

The γ radiation following the proton capture reaction ^{74}Ge(p,γ)^{75}As has been studied with a Ge(Li) detector. From the analysis of the measured γ-ray spectra, a detailed decay scheme of ^{75}As was constructed in which the energy levels of ^{75}As up to 2938 keV excitation were determined. Spin and parities for some levels are suggested. The deduced level schemes are in good agreement with results of Wilenzick et al. and Moreh and Shahal. (auth)

14255 SOME ASPECTS OF THE DECAY OF ^{62}Zn. Waters, S.L. (Medical Research Council, Cyclotron Unit, Hammersmith Hospital, London W12 OHS, England). Phys. Rev. C 9: No. 4, 1665-1667 (Apr 1974).

An ion-exchange column separation of ^{62}Zn/^{62}Cu has allowed careful measurement of the relative intensity of the 507-keV γ ray and the positron branching for ^{62}Zn. (auth)

14256 LEVELS IN ^{72}Se POPULATED BY ^{72}Br. Collins, W.E.; Hamilton, J.H. (Physics Department, Vanderbilt University, Nashville, Tennessee 37235); Robinson, R.L.; Kim, H.J.; Ford, J.L.C. Jr. Phys. Rev. C 9: No. 4, 1457-1466 (Apr 1974).

The level structure of ^{72}Se was investigated via the decay of ^{72}Br produced in the ^{58}Ni(^{16}O, pn) reaction. 32 transitions were assigned to ^{72}Se on the basis of half-life, energy, and/or relative γ-ray yields for different beam energies with 18 transitions confirmed by coincidence data. 32 transitions are placed into the decay sheme which consists of the following levels: 862.0, 2^+; 936.8, 0^+; 1316.7, 2^+; 1636.8, 4^+; 1876.0; 1998.4, $1,2^+$; 2150.3 (2^+); 2371.6, (2^+); 2433.2; 2586.2; 2965.6; 3124.1; 3225.9; and 3239.5 keV. The half-life of ^{72}Br was measured to be 1.31 ± 0.04 min. (auth)

14257 ELECTRON SCATTERING FROM ^{88}Sr AND ^{89}Y. Fivozinsky, S.P. (National Bureau of Standards, Washington, D.C. 20234); Penner, S.; Lightbody, J.W. Jr.; Blum, D. Phys. Rev. C 9: No. 4, 1533-1542 (Apr 1974).

Inelastic scattering cross sections of low-lying levels and elastic scattering cross sections have been measured in ^{88}Sr and ^{89}Y using the National Bureau of Standards Linac and electron scattering facility. Incident-electron energies were varied between 45 and 121 MeV corresponding to a momentum transfer range of 0.4 to 1.0 fm^{-1}. Data were accumulated at two scattering angles, 110.5 and 128.2°. We present elastic scattering form factors and inelastic scattering form factors and B(EL) †'s for the 1.84- and 2.74-MeV states in ^{88}Sr, and 1.51-, 1.74-, 2.21-, 2.52-, 2.86-, and 3.1-MeV states in ^{89}Y. A simple configuration mixing model based on the weak-coupling model has been applied to the octupole states in ^{89}Y. The measured elastic form factors for both nuclei have been fitted with a Fermi charge distribution. (auth)

14258 INVESTIGATION OF ^{67}Zn STATES BY THE ^{66}Zn(d,p) AND ^{63}Cu(^{3}He,p) REACTIONS. Ismail, H.A.; Moore, W.H.; Hallock, J.N.; Enge, H.A. (Department of Physics and Laboratory for Nuclear Science, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). Phys. Rev. C 9: No. 4, 1662-1664 (Apr 1974).

The ^{66}Zn(d,p)^{67}Zn and ^{63}Cu(^{3}He,p)^{67}Zn reactions have been studied at bombarding energies of 7.5 and 13.0 MeV, respectively. Below $E_x = 3.78$ MeV, 44 levels were observed in the (d,p) reaction while 25 levels below $E_x = 5.21$ were observed in the (^{3}He,p) reaction. (auth)

14259 EXCITATION FUNCTIONS FOR (p, n) REACTIONS TO 25 MeV ON ^{63}Cu, ^{65}Cu, AND ^{107}Ag. Collé, R.; Kishore, R.; Cumming, J.B. (Chemistry Department, Brookhaven National Laboratory, Upton, New York 11973). Phys. Rev. C 9: No. 5, 1819-1830 (May 1974).

Absolute cross sections for the (p, n) reactions on ^{63}Cu, ^{65}Cu, and ^{107}Ag at proton energies from 2.5 to 25 MeV were determined by the activation method. Metal foil targets of natural isotopic abundance were used; therefore, the results for ^{63}Zn above 22.3 MeV and for ^{107}Cd above 18.8 MeV include contributions from (p, 3n) reactions. Beam intensities were measured with a Faraday cup. Disintegration rates of the product nuclei were determined by assaying their γ rays with calibrated Ge(Li) detector systems. Comparisons of the present cross sections are made with a complete compilation of previous measurements and with calculations based on a Monte Carlo intranuclear-cascade-statistical-evaporation model. Half-lives for ^{63}Zn and ^{107}Cd were determined to be 38.0 ± 0.1 min and 6.50 ± 0.02 h, respectively. (auth)

14260 BACK-ANGLE ELASTIC AND INELASTIC SCATTERING OF α PARTICLES FROM THE EVEN Ni ISOTOPES. Trombik, W.; Eberhard, K.A.; Hinderer, G.; Rossner, H.H.; Weidinger, A. (Sektion Physik, Universität München, 8046 Garching, Germany); Eck, J.S. Phys. Rev. C 9: No. 5, 1813-1818 (May 1974).

Angular distributions for the elastic and inelastic scattering of α particles from the even Ni isotopes from 12.5 to 177.5° in the energy range from 18-27 MeV are reported. The β_2 coupling strengths to the first excited 2^+ state in each isotope are extracted from the data and are compared to similar results obtained at higher energy. The lack of any backward enhancement in the cross sections, in contrast to results reported for lighter nuclei, is explained on the basis of the level densities in the compound system. (auth)

14261 RADIATIVE DECAY OF NEUTRON RESONANCES IN ^{73}Ge(n, γ)^{74}Ge. Chrien, R.E.; Garber, D.I.; Holm, J.L.; Rimawi, K. (Brookhaven National Laboratory, Upton, New York 11973). Phys. Rev. C 9: No. 5, 1839-1847 (May 1974).

γ rays following neutron capture in natural germanium have been studied up to $E_n \approx 500$ eV with the fast chopper at the Brookhaven high flux beam reactor. Up to this energy only resonances in ^{73}Ge contribute. From the high-energy γ rays observed, levels in ^{74}Ge are identified to an excitation energy of about 3 MeV. From the low-energy γ rays depopulating the ^{74}Ge levels, spin assignments for several ^{73}Ge resonances are made; namely 102 eV, $J^\pi = 4^+$; 204 eV, $J^\pi = 5^+$; and 224 eV, $J^\pi = 4^+$. The results of the resonance capture experiments are compared to previous "average-resonance" and thermal-capture work, and in general are found to be in good agreement. Average radiative strengths for M1 and E2 transitions are calculated and compared to model estimates. (auth)

14262 NEUTRON-DEFICIENT ISOTOPES ^{64}Ge AND ^{65}Ge. Robertson, R.G.H.; Austin, S.M. (Cyclotron Laboratory and Physics Department, Michigan State University, East Lansing, Michigan 48824). Phys. Rev. C 9: No. 5, 1801-1812 (May 1974).

The β^+ decays of ^{65}Ge and the new isotope ^{64}Ge have been studied by γ-ray spectrometry with chemically separated sources. Measured half-lives are 30.0 ± 1.2 sec for ^{65}Ge and 63.7 ± 2.5 sec for ^{64}Ge. The decay-scheme studies have been supplemented by investigation of the ^{64}Zn(p, nγ)^{64}Ga and ^{64}Zn(^{3}He, t)^{64}Ga reactions, and the mass excess of ^{64}Ga was found to be -59.819 ± 0.008 MeV. Excitation functions for the (^{3}He, 2n), (^{3}He, 3n) and (^{3}He, p2n) reactions induced on ^{64}Zn are presented for comparison with other work. The question of the role of ^{64}Ge in nucleosynthesis is considered. (auth)

14263 FINAL-STATE l AND j DETERMINATION BY FORWARD-ANGLE MEASUREMENTS OF THE REACTION ^{62}Ni(^{7}Li,^{6}He)^{63}Cu. White, R.L.; Kemper, K.W.; Charlton, L.A.; Gunn, G.D. (Department of Physics, The Florida State University, Tallahassee, Florida 32306). Phys. Rev. Lett. 32: No. 16, 892-894 (22 Apr 1974).

In a study of the reaction ^{62}Ni(^{7}Li,^{6}He)^{63}Cu at 34.0 MeV, the angular distributions of the low-lying states have been observed to exhibit not

only an L dependence but also l and j dependences at angles forward of 15°. The l and j dependences of the shapes can be understood in terms of the angular-momentum selection rules. Finite-range distorted-wave Born approximation calculations, including recoil exactly, reproduce the data. Relative spectroscopic factors are in good agreement with those from the reaction ^{62}Ni(^{3}He,d)^{63}Cu. (auth)

14264 ENERGY DEPENDENCE OF ISOSPIN MIXING IN COMPOUND-STATISTICAL REACTIONS. Porile, N.T.; Pacer, J.C.; Wiley, J.; Lux, C.R. (Department of Chemistry, Purdue University, Lafayette, Indiana 47907). Phys. Rev. C 9: No. 6, 2171-2180 (June 1974).

The ^{66}Ga compound nucleus was formed at excitation energies ranging from 17 to 22 MeV in the reactions ^{63}Cu + α and ^{66}Zn + p and energy spectra of the emitted protons and α particles were measured between 30 and 150°. The extent of isospin mixing between the $T_>$ and $T_<$ states of the compound nucleus was determined by comparison of the quantity σ (p, p') σ (α, α')/σ (p, α) σ (α, p) with theory and the fractional mixing was found to increase from 0 to 0.3 over the above energy range. The mixing width shows a corresponding increase from 0.2 to 16 keV. The independence hypothesis was verified at all energies by measurements of the α and np exit channels. The various spectra were compared with the spin-dependent statistical theory. It was not possible to fit the data for various energies with energy-independent parameters in the Fermi gas model level density expression suggesting that this expression is inadequate. (auth)

14265 LOWEST RELIABLE LOGFT VALUE FOR SECOND-FORBIDDEN β TRANSITIONS. Raman, S. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830 and Institute for Nuclear Study, University of Tokyo, Tanashi-shi, Tokyo, Japan); Kawakami, H.; Ohya, S.; Matumoto, Z. Phys. Rev. C 9: No. 6, 2463-2465 (June 1974).

The 3/2 → 7/2 1.57-MeV β transition in ^{59}Fe decay is important for logft systematics because it has been considered to have the lowest logft value for any second-forbidden nonunique β transition. We have measured the intensity of the 1.57-MeV β group with an iron-free $\pi\sqrt{2}$ spectrometer. Our intensity value of 0.18 ± 0.04 per 100 decays leads to logft = 11.15 ± 0.11. This logft value strengthens the experimental bases for the "strong rule" proposed by Raman and Gove, that second-forbidden β transitions have logft ≥ 11.0. (auth)

14266 MEAN LIFETIMES OF LEVELS IN ^{59}Cu. Nelson, R.O.; Gould, C.R.; Tilley, D.R. (North Carolina State University, Raleigh, North Carolina 27607 and Triangle Universities Nuclear Laboratory, Durham, North Carolina 27706); Roberson, N.R. Phys. Rev. C 9: No. 6, 2193-2199 (June 1974).

The mean lifetimes of levels in ^{59}Cu below 3.6 MeV have been investigated with the Doppler-shift attenuation method and the ^{58}Ni(^{3}He, d)^{59}Cu reaction at 11.6 MeV. Scattered particles were detected in two E-ΔE telescopes at ±55° with respect to the beam axis, in coincidence with γ rays observed at 90° in a 50-cc Ge(Li) detector. New levels were observed at 3114 and 3615 keV. Mean lifetimes are reported for the following levels (energy in keV, lifetime in fs): 491 (830 ± 300), 914 (> 1600), 1399 (570 ± 240), 2266 (310 ± 140), 2324 (36 ± 5), 3043 (1150 ± 500), 3114 (20 ± 11), 3130 (10 ± 4), 3551 (< 15), 3580 (2400 ± 1400) and 3615 (< 35). The experimental results are compared with the predictions of a core-particle coupling calculation. (auth)

14267 ISOMERIC STATE IN ^{74}Ga. van Klinken, J.; Taff, L.M. (Laboratorium voor Algemene Natuurkunde, and Kernfysisch Versneller Institut, Rijksuniversiteit, Groningen, The Netherlands). Phys. Rev. C 9: No. 6, 2252-2260 (June 1974).

A 9.5-s activity with an isomeric transition of unusually low energy (3.2 keV) and a subsequent transition of 56.5 keV has been assigned to ^{74}Ga^m. The activity has been produced by 14-MeV neutrons in samples of ^{74}Ge. Since this target nucleus has an abundance of 37% in natural germanium, summing of the 3.2- and 56.5-keV transitions could be observed by neutron activation of a Ge detector. Further experiments utilized fast transport and analysis of x rays, β rays, and sum peaks. Combining the results with recent information on the decay of ^{74}Zn, spins and parities could be proposed for levels of ^{74}Ga at 56.5, 59.7, 108.6, and 250.0 keV. For the ground state we propose $J^\pi = 4^-$, which is in contrast with previous suggestions of 3⁻ based on analogy to the neighboring isotopes ^{72}Ga and ^{76}Ga. (auth)

Nuclear Properties and Reactions, 90 ≤ A ≤ 149

Refer also to abstracts 12750, 13875, 14208, 14249, 14250, 14259, 14302, 14303, 14351, 14359, 14360, and 14363.

14268 (COO-3239-11) NUCLEAR CHEMISTRY RESEARCH OF HIGH ENERGY NUCLEAR REACTIONS AT CARNEGIE-MELLON UNIVERSITY. Annual Progress Report, 1973-1974. Caretto, A. A. Jr. (Carnegie-Mellon Univ., Pittsburgh, Pa. (USA). Dept. of Chemistry). May 1974. Contract AT(11-1)-3239. 27p. Dep. NTIS $4.50.

Progress in the study of high energy nuclear reactions between June 1, 1973 and May 31, 1974 is reported. Five different major experiments were investigated: the ^{48}Ti(p,2p)^{48}Sc and ^{48}Ti(p,pπ⁺)^{47}Sc reaction cross sections were measured at 300 GeV. The production ratio of ^{48}Sc/^{47}Sc was about the same as for other systems at lower energies. These cross sections will be measured at lower energies and the effect of secondaries determined. Cross sections for the production of (α,αn) and (α,αp) reactions on ^{90}Zr, ^{96}Zr, ^{98}Mo, and ^{96}Ru and ^{102}Pd were measured with 700 MeV alpha particles. When final values are available they will be compared with the neutron skin thickness of the target since nucleon knock-out reactions might be expected to be dependent on this quantity. The isobaric yield distribution of A ~ 72 products from ^{92}Mo, ^{96}Mo, and ^{100}Mo has been determined using 700 MeV alpha particles. The peak position of the distribution seems insensitive to target composition, however the yields in the wings vary markedly with target, the neutron excess yields increasing with increasing neutron number of the target. Pion-neutron knock-out reaction cross sections were measured at the 3/3-3/3 pion nucleon resonance energy. The value for the ^{12}C(π⁺,π⁺n + π⁰p)^{11}C reaction is 52 ± 6 mb distinctly different from a previously reported value. Cross sections for other target systems are also reported. A study of α-transfer reactions involving the interactions of heavy ions with ^{63}Cu and ^{65}Cu to produce ^{68}Ga and ^{71}As is reported. The probability of the various mechanisms is discussed. Listings of publications are included. (auth)

14269 (FEI-368) ESTABLISHMENT OF NEUTRON ENERGY SPECTRA FROM TRANSMISSION DATA. Van'kov, A. A.; Voropaev, A. I. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk. Fiziko-Ehnergeticheskij Inst.). 1973. 20p. (In Russian). INIS.

Results are presented in establishing the energy spectrum (of the fast neutron fraction in a group) from transmission data at good geometry. As filters, materials were chosen with a well known total cross-section, whose energy dependence carries a monotonic character or has a resonance form in the presence of one of the most sharply expressed resonances. The treatment algorithm (iteration process) assured positiveness and normalization of the solution in a given energy region. Numerous tests showed the efficiency and reliability of the algorithm. Particular attention was devoted to the problem of error in the results. (SJR)

14270 RESONANT SCATTERING OF BREMSSTRAHLUNG BY ^{90}Zr. Metzger, F.R. (Bartol Research Foundation of The Franklin Institute, Swarthmore, Pennsylvania 19081). Phys. Rev. C 9: No. 4, 1525-1528 (Apr 1974).

Resonant scattering of bremsstrahlung photons has been observed for the 3.308-(2⁺), 3.842-(2⁺), 4.580-, and 5.504-MeV(1⁽⁻⁾) levels in ^{90}Zr in addition to the previously excited 2.186-MeV 2⁺₁ level. The angular distribution of the 4.580-MeV radiation characterizes the spin of this level as 1. From the yield data and reported branching ratios, radiative widths of 4.6 ± 0.8, 28 ± 4, 48 ± 13, and 80 ± 32 meV were obtained for the ground-state transitions. The E2 transition strengths measured for the three 2⁺ states in this model-independent way are compared with the strengths deduced from the cross sections of (α, α') and other inelastic scattering reactions. (auth)

14271 COMPARISON OF THE INELASTIC SCATTERING OF PROTONS BY ^{144,154}Sm IN THE REGION OF GIANT RESONANCES. Horen, D.J.; Bertrand, F.E.; Lewis, M.B. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). Phys. Rev. C 9: No. 4, 1607-1610 (Apr 1974).

Measurements of the inelastic proton spectrum in the giant-resonance region of the nuclear continuum for ^{144}Sm and ^{154}Sm have been made using 67-MeV protons. The spectra from the spherical and deformed targets are essentially identical in the resonance region above ≈ 12.8 MeV of excitation. Although the observed resonance peak locations and cross section are consistent with excitation of the giant dipole and giant quadrupole resonances, such an interpretation may lead to inconsistencies with the E1 splitting reported for ^{154}Sm in photonuclear reactions. (auth)

14272 NEUTRON-RESONANCE CAPTURE GAMMA RAYS IN ^{136}Ba. Chrien, R.E.; Cole, G.W.; Holm, J.L.; Wasson, O.A. (Physics Department, Brookhaven National Laboratory, Upton, New York 11973). Phys. Rev. C 9: No. 4, 1622-1632 (Apr 1974).

Earlier experiments have reported an anomalous M1 strength for the ground-state radiative transition in ^{136}Ba following neutron capture. Barium has been restudied in discrete resonance and average resonance capture. The γ-ray widths are measured and tabulated. We find a γ-ray strength function for M1 transitions of (20 ± 7) × 10⁻⁹ MeV⁻³ from a study of capture in discrete resonances below 500 eV. From a

study of neutron capture in an energy band 2 keV wide at 24.5 keV we find comparable values. These values are near the mean value (18×10^{-9}) MeV^{-3} observed for all nuclei; hence we conclude that the average M1 strength in ^{136}Ba is quite normal. Additional widths for primary E1 and M1 transitions are also reported. A detailed multilevel analysis of the partial (n, γ) cross sections below the first ^{135}Ba resonance at 24 eV shows a negligible direct M1 component. (auth)

14273 CORE COUPLING IN ^{99}Nb. Bindal, P.K.; Youngblood, D.H. (Cyclotron Institute and Physics Department, Texas A&M University, College Station, Texas 77843). Phys. Rev. C 9: No. 4, 1618-1621 (Apr 1974).

The ^{100}Mo(d, ^{3}He)^{99}Nb reaction at 40.7-MeV bombarding energy was used to obtain excitation energies, spectroscopic factors, and l-value assignments for levels in ^{99}Nb. A core-coupling model is used to predict these properties and agreement with experiment is found to be good. (auth)

14274 STRUCTURE OF ^{113}In STUDIED VIA THE REACTIONS ^{115}In(p, t)^{113}In, ^{112}Cd(^{3}He, d)^{113}In, AND ^{112}Cd(^{4}He, t)^{113}In. Markham, R.G.; Fulbright, H.W. (Nuclear Structure Research Laboratory, University of Rochester, Rochester, New York 14627). Phys. Rev. C 9: No. 4, 1633-1642 (Apr 1974).

^{115}In(p, t)^{113}In, ^{112}Cd(^{3}He, d)^{113}In, and ^{112}Cd(α, t)^{113}In experiments have been done and distorted-wave Born approximation analysis has been used to obtain L transfers and spectroscopic factors. Several new levels are reported and J^π assignments are proposed. Two sets of states observed via the two types of reactions are classified as hole-core levels formed by coupling a proton hole to the states of ^{114}Sn, and particle-core levels formed by coupling a proton to the states of ^{112}Cd. Results of particle-core and hole-core model calculations are consistent with the observed spectroscopic factors and with the proposed level scheme. (auth)

14275 HIGH-RESOLUTION STUDY OF THE 1/2$^+$ ANALOG STATE IN ^{93}Tc. Bilpuch, E.G.; Moses, J.D.; Purser, F.O.; Newson, H.W. (Duke University and Triangle Universities Nuclear Laboratory, Durham, North Carolina 27706); Mitchell, G.E.; Nelson, R.O.; Outlaw, D.A. Phys. Rev. C 9: No. 4, 1589-1593 (Apr 1974).

The ^{92}Mo(p, p) excitation function was measured with high energy resolution over the 1/2$^+$ analog state at 5.3 MeV. A total of 125 s-wave resonances were resolved and analyzed. Results of the analysis of the analog-state fine structure are presented. The average level spacing and the parent-state spectroscopic factor are calculated. (auth)

14276 INELASTIC PROTON SCATTERING FROM ^{138}Ba AND ^{144}Sm AT 30 MeV. Larson, D.; Austin, S.M.; Wildenthal, B.H. (Cyclotron Laboratory and Department of Physics, Michigan State University, East Lansing, Michigan 48824). Phys. Rev. C 9: No. 4, 1574-1588 (Apr 1974).

Differential cross sections for elastic and inelastic scattering of 30-MeV protons by ^{138}Ba and ^{144}Sm have been measured with a total energy resolution for the inelastic peaks of 7-10 keV, full width at half maximum. This permitted the observation of 20 excited states in ^{138}Ba and 18 excited states in ^{144}Sm below $E_x = 3.4$ MeV, and the determination of excitation energies accurate to 2 keV or less for these states. Based on characteristic shapes derived from angular distributions to states of known J^π, spin-parity assignments were made for the majority of the observed states. Collective-model distorted-wave Born-approximations calculations for the observed transitions were compared to the data, and deformation parameters extracted for all states to which J^π could be assigned. The energy-level structures of these nuclei, obtained by combining the present results with information in the literature, are compared to the predictions of structure calculations based on the assumption of a closed N=82, Z=50 core. (auth)

14277 SUB-COULOMB (d,p) STRIPPING ON THE N=82 ISOTONES. Norton, G.A.; Gearhart, N.L.; Hausman, H. J.; Morgan, J.F. (Department of Physics, The Ohio State University, Columbus, Ohio 43210). Phys. Rev. C 9: No. 4, 1594-1600 (Apr 1974).

Stripping reactions (d,p) have been performed on ^{139}La, ^{140}Ce, ^{141}Pr, ^{142}Nd, and ^{144}Sm in which both the entrance and exit channels are below the Coulomb barrier. Reduced normalizations have been extracted from this data and are shown to be insensitive to the optical-model parameters used in the distorted-wave Born-approximation analysis. The Q dependence of the reduced normalizations is also noted. (auth)

14278 MEASUREMENTS OF THE ELECTRON-PHOTON DOUBLE DECAY IN ^{113}In AT 35°. Jurčević, M.; Ilakovac, K.; Krečak, Z. (Institute "Rudjer Bošković," Zagreb, Yugoslavia). Phys. Rev. C 9: No. 4, 1611-1617 (Apr 1974).

Double- and triple-coincidence measurements of the electron-photon decay of the 392-keV state in ^{113}In were performed at a relative angle of emission of 35°. The method of three-dimensional analysis was applied to record the amplitudes of pulses from the electron and phonon detectors and the time difference in the occurrence of pulses. K γ decay was well resolved from higher-shell decays, but Lγ, Mγ, and Nγ decays were not resolved. The energy spectrum of photons for Kγ and (L + M + N) γ decays was derived from the experimental data. The results are in agreement with the theory of the internal Compton effect of Spruch and Goertzel. (auth)

14279 COMPARISON OF SUB-COULOMB (d,p) STRIPPING TO ANALOG RESONANCE RESULTS FOR N=82 ISOTONES. Norton, G.A.; Hausman, H.J.; Morgan, J.F. (The Ohio State University, L.D.o.P., Columbus, Ohio 43210). Phys. Rev. C 9: No. 4, 1601-1606 (Apr 1974).

Reduced normalizations have been extracted from proton elastic scattering data via isobaric-analog resonance for analogs of low-lying parent states in ^{139}Ba, ^{141}Ce, ^{143}Nd, and ^{145}Sm, by the use of three different analog resonance theories. The reduced normalizations were compared to those obtained from sub-Coulomb (d,p) stripping to the low-lying parent states of the above nuclei. This comparison shows that the R-matrix theory gives the best agreement to the (d,p) results. (auth)

14280 NUCLEAR MAGNETIC MOMENTS OF VERY SHORT-LIVED STATES VIA THE TRANSIENT-FIELD IMPLANTATION PERTURBED-ANGULAR-CORRELATION TECHNIQUE. Hubler, G.K.; Kugel, H.W. (Rutgers University, New Brunswick, New Jersey 08903); Murnick, D.E. Phys. Rev. C 9: No. 5, 1954-1964 (May 1974).

The Lindhard and Winther equations for the transient magnetic field effect have been numerically integrated with the inclusion of a decays-in-flight correction and using the best available stopping power formulas. The calculations are carried out for an iron host and curves are generated from which the transient-field angular shift may be predicted for any $Z > 12$ to an accuracy of ~ 20%. The transient-field calculations are employed in the analysis of angular shift data for the first 2$^+$ states of ^{104}Pd, ^{106}Pd, ^{108}Pd, and ^{110}Pd isotopes implanted into a $Fe_{0.8}$-$Co_{0.2}$ alloy and for ^{54}Fe and ^{56}Fe implanted into iron. The g factors of the six isotopes are obtained and the hyperfine field of Pd in the alloy is determined. Evidence is presented which suggests that the hyperfine fields measured in oxygen beam implantation perturbed-angular-correlation experiments for Ru, Pd, Cd, and Te in Fe are consistently reduced from the hyperfine fields measured by other methods. In light of these results and the decays-in-flight corrections to the transient field theory, angular shift data of previous workers on even-even isotopes of Ge, Ru, Pd, Cd, and Te have been reanalyzed. With the exception of ^{70}Ge, all the g factors are in agreement with a collective model. (auth)

14281 RADIATIVE DECAY OF NEUTRON RESONANT STATES IN RUTHENIUM. Rimawi, K.; Garg, J.B. (State University of New York, Albany, New York); Chrien, R.E.; Cole, G.W.; Wasson, O.A. Phys. Rev. C 9: No. 5, 1978-1990 (May 1974).

γ rays following slow-neutron capture in natural ruthenium have been studied. Spin and isotopic assignments for resonances have been made based on high- and low-energy γ-ray transitions. In the case of the product nuclei ^{100}Ru-^{102}Ru, the present (n, γ) studies extend our knowledge of the level schemes to energies higher than previously available from β-decay studies of Rh and Tc isotopes. A notable feature of the data is a relatively high concentration of radiation strength between 6.5 and 7.0 MeV for both ^{100}Ru and ^{102}Ru. M1 enhancement could be ascribed to a doorway state in neutron capture leading to spin-flip transitions of the $g_{7/2} \rightarrow g_{9/2}$ type. (auth)

14282 PROBABILITY OF K-SHELL AUTOIONIZATION IN THE β^- DECAY OF ^{114}In. van Eijk, C.W.E.; Kooy, R.W.; Visscher, M.J.C. (Physics Department, University of Technology, Delft, Netherlands). Phys. Rev. C 9: No. 5, 2074-2075 (May 1974).

The K-shell autoionization probability in the β^- decay of ^{114}In has been measured using a curved-crystal spectrometer. A value of $(5.4 \pm 0.4) \times 10^{-4}$ was obtained for the number of K-shell vacancies per β decay. This result is in excellent agreement with the theoretical value predicted by Law and Campbell, which is 5.42×10^{-4}. (auth)

14283 ^{94,96}Mo(^{12}C, ^{12}C)^{95,97}Mo REACTIONS. Bond, P.D.; Chasman, C.; LeVine, M.J.; Schwarzschild, A.Z.; Thorn, C.E.; Baltz, A.J. (Brookhaven National Laboratory, Upton, New York 11973). Phys. Rev. C 9: No. 5, 2001-2009 (May 1974).

The levels of ^{95,97}Mo below 1.2 MeV in excitation have been studied with the ^{94,96}Mo(^{12}C, ^{12}C) reactions. Relative cross sections to the very closely spaced excited states were determined by particle-γ coincidence measurements. Generally excellent agreement between the measured cross sections and those calculated by a direct transfer code, which includes recoil correctly to first order, was found. The selectivity of this heavy-ion reaction was used to determine spin assignments which were ambiguous in light-ion experiments. The importance of two-step processes on the magnitude of the cross section was investigated. One state showed a strong enough deviation from distorted-wave Born-approximation calculations to suggest the influence of such two-step processes. (auth)

14284 NUCLEAR MOMENTS OF ^{102}Ag^m AND ^{106}Ag^g. Greenebaum, B.; Phillips, E.A. (Jadwin Physical Laboratory, Princeton

University, Princeton, New Jersey 08540). Phys. Rev. C 9: No. 5, 2028-2032 (May 1974).

On-line atomic-beam-magnetic-resonance experiments at the Princeton cyclotron were used to measure the magnetic hyperfine structure transitions involving the isomeric state of ^{102}Ag ($T_{1/2}$ = 8 min, I = 2) and the ground state of ^{106}Ag ($T_{1/2}$ = 24 s, I = 6). The radioactive nuclei were formed by a (p, n) reaction on palladium inside the oven of the atomic beam apparatus. The values of magnetic dipole interaction constant are A(102) = 15060 ± 900 MHz and A(106) = 20345 ± 600 MHz. From these measurements we infer the values of the nuclear magnetic dipole moments to be μ (102) = +(4.12 ± 0.25) μ_N and μ (106) = +(2.83 ± 0.2) μ_N. (auth)

14285 NUCLEAR g FACTOR OF THE 204-keV LEVEL IN ^{95}Mo. Garber, D. A.; Behar, M.; Grabowski, Z. W.; King, W. C. (Tandem Accelerator Laboratory, Purdue University, West Lafayette, Indiana 47907). Phys. Rev. C 9: No. 5, 2080-2083 (May 1974).

The ion-implantation-perturbed-angular-correlation technique (IMPACT) has been used to measure the g factor of the 204-keV $3/2^+$ level in ^{95}Mo nuclei recoiled into ferromagnetic iron and cobalt hosts. The observed angular precessions were $\omega\tau$ (FeMo) = 0.32 ± 0.05 and $\omega\tau$ (CoMo) = 0.18 ± 0.03. The available direct lifetime measurements for the 204-keV states and the NMR hyperfine field measurements for molybdenum solutes in iron and cobalt are used to obtain the gyromagnetic ratio g(204) = -0.24 ± 0.03. The sign of the hyperfine field for molybdenum in iron host was found to be negative. (auth)

14286 MEASUREMENTS OF THE TOTAL CROSS SECTIONS OF Cd, Ag, Bi, AND Sr BY NEUTRONS FROM 18.44 TO 21.95 MeV. Ortega, R. M. Veracruz, Mexico; Universidad Veracruzana (1974). 85p. (In Spanish).

Thesis.

The classic and quantum concepts of the total effective cross section are established. The kinematics of the nuclear reactions are analyzed. Some monoenergy neutron sources and the techniques of neutron detection are described. The experimental instrumentation used in the present measurements is discussed. The results obtained are tabulated and graphed. (JSR)

14287 DO THE 3 OCTUPOLE STATES IN THE EVEN Cd ISOTOPES EXIST? Gill, D.R.; Ahmed, N.; McDonald, W.J.; Neilson, G.C. (Nuclear Research Centre, University of Alberta, Edmonton, Alberta, Canada). Phys. Rev. Lett. 32: No. 16, 889-891 (22 Apr 1974).

In high-resolution (n,n'γ) studies the previously assigned 3^- octupole states in ^{114}Cd and ^{116}Cd have not been observed. (auth)

14288 LEVELS IN ^{140}Ba POPULATED IN THE DECAY OF 64-SEC ^{140}Cs. Schick, W.C. Jr.; Talbert, W.L. Jr. (Ames Laboratory, United States Atomic Energy Commission, and Department of Physics, Iowa State University, Ames, Iowa 50010). Phys. Rev. C 9: No. 6, 2328-2339 (June 1974).

The γ-ray decay of 64-sec fission-product ^{140}Cs has been studied using the TRISTAN on-line isotope-separator system. Ge(Li) detector singles and Ge(Li)-Ge(Li) coincidences were performed. 154 γ-ray transitions were assigned to a level scheme for ^{140}Ba with 30 definite and 13 tentative excited levels. Tentative spin and parity assignments were made for some of these levels. The relationship between ^{140}Ba and the other even Ba isotopes is discussed, and an interesting similarity with ^{134}Ba is noted. (auth)

14289 OBSERVATION OF A WEAK BETA-DECAY BRANCH IN ^{99}Tc. Engelke, C.E.; Ullman, J.D. (Department of Physics and Astronomy, Herbert H. Lehman College of the City University of New York, Bronx, New York 10468). Phys. Rev. C 9: No. 6, 2358-2362 (June 1974).

An 89-keV γ line has recently been observed in ^{99}Tc and attributed to a weak (1.6×10^{-5}) β branch leading to the 89-keV level in ^{99}Ru. However, the long ^{99}Tc lifetime makes it difficult to be sure such a γ line is not due to a long-lived contaminant. We have observed the 89-keV transition and measured the half-life of the state feeding it, using the delayed coincidence method: the result (18.9 ± 1.0 nsec) agrees with measurements of the lifetime of the ^{99}Ru 89-keV state. The β group in coincidence with the 89-keV γ line also shows an end-point energy about 89 keV less than that of the ground-state group. These results confirm the existence of the proposed weak β branch, for which we find a branching ratio of (1.2 ± 0.4) $\times 10^{-5}$. (auth)

14290 ANGULAR CORRELATION STUDY OF ^{129}I POPULATED IN THE DECAY OF ^{129}Te. De Raedt, J.; Rots, M.; Van de Voorde, H. (Katholieke Universiteit Leuven, Departement Natuurkunde Celestijnenlaan 200 D, 3030 Heverlee, Belgium). Phys. Rev. C 9: No. 6, 2391-2398 (June 1974).

From coincidence measurements on γ-γ cascades following the decay of ^{129}Te^m the existence of a 1047-keV level in ^{129}I is well established. Angular correlation measurements for several cascades give the following values: 281-251 keV cascade: A_{22} = 0.238 ± 0.015, A_{44} = 0.014 ± 0.026; 209-251 keV cascade: A_{22} = 0.234 ± 0.012, A_{44} = 0.011 ± 0.022; 281-278 keV cascade: A_{22} = -0.048 ± 0.014, A_{44} = -0.014 ± 0.023; 209-278 keV cascade: A_{22} = -0.059 ± 0.011, A_{44} = 0.018 ± 0.018; 624-209 keV cascade: A_{22} = -0.270 ± 0.065, A_{44} = 0.047 ± 0.095; 624-460 keV cascade: A_{22} = 0.151 ± 0.009, A_{44} = 0.003 ± 0.012; 624-478 keV cascade: A_{22} = -0.290 ± 0.025, A_{44} = -0.002 ± 0.036; 343-460 keV cascade: A_{22} = -0.341 ± 0.058, A_{44} = 0.033 ± 0.080. These values, together with nuclear orientation data, uniquely determine the spin of the excited states at 278 keV (3/2) and 860 keV (3/2). The mixing ratios δ (E2/M1) for the different transitions are obtained. (auth)

14291 GENERALIZED SEMIMICROSCOPIC MODEL IN ODD-MASS INDIUM ISOTOPES. Abecasis, S.M. (Laboratorio de Radiaciones, IIAE, Departamento de Física, Facultad de Ciencias Exactas y Naturales, Ciudad Universitaria, Pabellón 1, Nuñez, Buenos Aires, Argentina); Civitarese, O.; Krmpotić, F. Phys. Rev. C 9: No. 6, 2320-2327 (June 1974).

A generalization of the classical semimicroscopic model is developed to explain simultaneously quasivibrational and quasirotational nuclear states. The wave functions obtained are used to calculate level sequences, electromagnetic properties, and spectroscopic factors. Experimental data are reasonably well fitted. (auth)

14292 RADIOACTIVE DECAY OF 9.2-MIN ^{130}I^m TO LEVELS OF ^{130}Xe. Meyer, R.A. (Lawrence Livermore Laboratory, Livermore, California 94550); Walters, W.B. Phys. Rev. C 9: No. 6, 2379-2383 (June 1974).

The γ-ray transitions following the decay of 9.2-min ^{130}I^m have been measured using Ge(Li) Compton-suppressed γ-ray spectrometry. Three new levels in ^{130}Xe have been proposed at 2762.6, 2644.9, and 2307.8 keV and new β branches observed to four levels at 1632.6, 2385.5, 2544.4, and 2637.5 keV. The results are compared with those of other recent studies and the difficulties of finding an adequate theoretical description discussed. (auth)

14293 NEUTRON-CAPTURE GAMMA RAYS FROM THE 9.47-eV RESONANCE IN ^{129}Xe(n, γ)^{130}Xe. Gelletly, W. (Schuster Laboratory, University of Manchester, Manchester, United Kingdom); Kane, W.R.; MacKenzie, D.R. Phys. Rev. C 9: No. 6, 2363-2378 (June 1974).

The γ-ray spectrum from neutron capture in the 9.47-eV resonance in ^{129}Xe has been studied. A target of Na_4XeO_6 was irradiated in a thermal neutron beam and in a monochromatic neutron beam of 5.16-, 9.47-, and 14.1-eV energy from a crystal diffraction neutron monochromator. The resulting γ-ray spectra were studied with Ge(Li) detectors of ≃20-, ≃25-, ≃30-, and ≃40-cm^3 active volume. γ rays were assigned to the ^{129}Xe(n γ)^{130}Xe reaction by a comparison of these spectra. Ge (Li)-Ge (Li) coincidence measurements were carried out on resonance with the 20- and 30-cm^3 Ge (Li) detectors in combination. Only a few very intense transitions were observed in coincidence. The data obtained in the present work together with the information from earlier radioactive decay studies indicate the population of levels in ^{130}Xe by neutron capture in the 9.47-eV resonance with energies 536.1 ± 0.2, 1122.1 ± 0.3, 1204.4 ± 0.5, 1631.8 ± 0.7, 1785.9 ± 0.8, 1792.1 ± 0.6, 1807.9 ± 0.4, 2017.0 ± 0.5, 2058.7 ± 0.9, 2081.4 ± 0.9, 2171.0 ± 1.3, 2222.6 ± 0.6, 2241.5 ± 0.6, 2385.1 ± 0.5, 2501.9 ± 0.5, 2544.4 ± 0.9, 2632.4 ± 1.7, (2762.7 ± 0.5), 2885.6 ± 1.1, 2953.5 ± 0.5, 2977.5 ± 1.0, 3071.1 ± 0.8, 3150.1 ± 0.7, 3188.8 ± 0.6, (3243.2 ± 1.3), 3298.0 ± 1.2, 3325.1 ± 0.8, 3405.2 ± 0.7, 3534.2 ± 0.6, 3621.9 ± 0.7, 3685.6 ± 1.0, 3780.0 ± 1.2, 3892.2 ± 1.5, (3960.1 ± 1.0), 3976.3 ± 1.5, and 3985.6 ± 1.0 keV. The neutron separation energy of ^{130}Xe is 9254.7 ± 1.3 keV. The observation of the 9254.2 ± 2.1 keV primary-capture γ ray to the 0+ ground state of ^{130}Xe clearly establishes the spin of the 9.47-eV resonance in ^{129}Xe as 1+. (auth)

14294 NUCLEAR MAGNETIC RESONANCE. Rushworth, F. A.; Tunstall, D. P. Documents on Modern Physics. New York; Gordon and Breach, Science Publishers, Inc. (1973). 263p. $24.00.

The purpose of this book is to give a readable introduction of NMR suitable for "special topic" courses at the undergraduate or post-graduate level in physics and chemistry; in order to show the power of the method, selected applications are probed more deeply. The first three chapters, Introduction, General theory of magnetic resonance, and Experimental, require a minimum of groundwork in physics and mathematics to be understood. More specialized chapters with the following titles follow: Dipole-dipole interactions in solids, Electron-nuclear interactions, Liquids, Metals, and in the rotating frame. Appendixes on quantum mechanics and commonly used nuclei and suggestions for further reading are included. (52 figures, 6 tables, 120 references) (RWR)

14295 COEXISTENCE OF THREE-PARTICLE CLUSTERING AND COLLECTIVE CORE VIBRATIONS IN ^{128}I. Vanden Berghe, G. (Rijksuniversiteit, Ghent). Z. Phys.; 266: No. 2, 139-148 (Jan 1974).

The model of a three-particle proton cluster coupled to the quadrupole vibrational field is applied to ^{125}I. The energy spectrum and spectroscopic factors, as obtained in a (^{3}He,d) stripping reaction, are calculated and compared with experimental data. With the wave functions obtained, magnetic dipole and electric quadrupole moments are derived. (1 figure, 3 tables) (auth)

Nuclear Properties and Reactions, 150 ≤ A ≤ 189

Refer also to abstracts 14208, 14271, 14350, 14360, 14362, and 14363.

14296 CORIOLIS PERTURBATION EFFECTS FOR $K^\pi = 3/2^-$ BANDS IN ODD-NEUTRON RARE-EARTH NUCLEI. Joshi, P.C.; Sood, P.C. (Nuclear Physics Section, Department of Physics, Banaras Hindu University, Varanasi 221005 India). Phys. Rev. C 9: No. 5, 1965-1971 (May 1974).

The energy spacings of rotational levels in $K^\pi = 3/2^-$ bands in odd-neutron rare-earth nuclei are seen to exhibit an alternating behavior with the level spin. This behavior is analyzed empirically, phenomenologically, and theoretically. It is shown that the alternating term in phenomenological rotational energy expression is even more significant than the usual $I^2(I+1)^2$ correction term in most of the nuclei. Theoretical calculations employing Nilsson-model single-particle orbitals and including the contributions of admixtures from various N = 5 oscillator shell 1/2 single-particle states to perturb the rotational levels based on 3/2 [521] states show that this behavior may reasonably be described as resulting from the third-order perturbation effects of the Coriolis interaction term in the Hamiltonian. (auth)

14297 MULTIPOLE MIXTURES OF GAMMA-RAY TRANSITIONS DEPOPULATING THE 1318-keV (2$^-$) AND 1518-keV (6$^+$ OR 7$^-$) STATES IN ^{174}Yb. Schmidt, A.G.; Mihelich, J.W.; Funk, E.G. (Department of Physics, University of Notre Dame, Notre Dame, Indiana 46556). Phys. Rev. C 9: No. 6, 2346-2357 (June 1974).

An E1 + E3 ($\lesssim$1.9% M2) multipole mixture has been observed for the 1242-keV ($2^- \rightarrow 2^+$) transition depopulating the J^π, $K = 2^-$,2 octupole vibrational level at 1318 keV in ^{174}Yb following the decay of ^{174}Lu and ^{174}Lu^m. The internal-conversion coefficient for this transition and the γ-γ directional correlation for the 1242-76.5-keV cascade have been remeasured, and the results yield the unique set of multipole mixing ratios δ_1(M2/E1) = 0.05 ± 0.09 and δ_2(E3/E1) = 0.19 ± 0.08 which correspond to a multipole admixture of $E1(96.3^{+1.7}_{-2.4}\%) + M2(0.2^{+1.7}_{-0.2}\%) + E3(3.5^{+3.8}_{-2.1}\%)$. The M2 multipolarity of the 1318-keV ($2^- \rightarrow 0^+$) transition was also verified from the measured internal-conversion coefficient. A multipole admixture of E3 (<27% M2) for the 1065-keV transition was deduced from available data, and the ratios of reduced transition probabilities for the transitions depopulating the 1318-keV level were calculated and compared with rotational-model predictions. Using the previously measured half-life of the 2$^-$ level, absolute transition probabilities and hindrance factors were obtained for these transitions, and B(E3) values were compared with theoretical microscopic model calculations. Partial correlation coefficients for the 992-keV transition depopulating the 1518-keV isomeric state were determined using the γ-γ directional correlation data. Multipole admixtures consistent with the correlation data (and internal conversion data for the 7$^-$ case) are E2 + (27 ± 8%)M1 for the choice of 6$^+$ and E1(68 ± 7%) + M2(5 ± 2%) + E3(27 ± 7%) for the choice of 7$^-$ for the 1518-keV level. Using the reported half-life for that level, the hindrance factors were obtained for the K-forbidden transitions depopulating the level for each choice of spin assignment and these are compared with hindrance factors observed for known K-forbidden transitions. (auth)

14298 CONFIGURATION MIXING OF TWO-QUASIPARTICLE STATES IN EVEN-EVEN DEFORMED NUCLEI. Massmann, H.; Rasmussen, J.O. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720); Ward, T.E.; Haustein, P.E.; Bernthal, F.M. Phys. Rev. C 9: No. 6, 2312-2319 (June 1974).

Evidence of configuration mixing of higher-K bands in deformed even nuclei is surveyed. A general formulation for configuration mixing due to a two-body neutron-proton force is developed. A fit to the energy splittings of Gallagher-Moszkowski pairs in odd-odd nuclei is made to obtain an effective Gaussian central force except for the undetermined Wigner component. With this force, off-diagonal band-mixing matrix elements are calculated for various configurations in ^{176}Hf, ^{178}Hf, and ^{174}Yb. By solving BCS equations, the relevant occupation amplitudes are calculated. The effective n-p Wigner force component is fixed to give best over-all agreement to experimental band-mixing information. The resulting force is compared with the Jones, Onishi, Hess, and Sheline central force for deformed nuclei. (auth)

14299 NUCLEAR g FACTORS OF FIRST 2$^+$ STATES IN EVEN TUNGSTEN NUCLEI DETERMINED BY RECOIL IMPLANTATION INTO NICKEL AND COBALT, AND THE HYPERFINE FIELD ON TUNGSTEN NUCLEI IN NICKEL AND COBALT. Garber, D.A.; Behar, M.; King, W.C.; Grabowski, Z.W.; Scharenberg, R.P.; Sioshansi, P.; Wheeler, R.M. (Tandem Accelerator Laboratory, Purdue University, Lafayette, Indiana 47907). Phys. Rev. C 9: No. 6, 2399-2405 (June 1974).

The ion-implantation-perturbed-angular-correlation technique has been used to measure the Larmor precessions of the first 2$^+$ excited states of ^{182,184,186}W in a ferromagnetic nickel host. The observed angular precessions, corrected for the transient field effect, were $\omega\tau_{182}(2^+)$ = 0.159 ± 0.003 rad, $\omega\tau_{184}(2^+)$ = 0.156 ± 0.011 rad, and $\omega\tau_{186}(2^+)$ = 1.160 ± 0.007 rad. Use is made of the accepted g factor of ^{184}W, $g_{184}(2^+) = 0.288 \pm 0.007$, to obtain in H_{hf}(Ni-W) = (−67 ± 5) kOe at 305 K. The g factors of ^{182,186}W, determined relative to the known g factor of ^{184}W, are $g_{182}(2^+) = 0.271 \pm 0.021$, and $g_{186}(2^+) = 0.370 \pm 0.036$. Larmor precessions were also measured for the first 2$^+$ excited states of ^{184,186}W in a ferromagnetic cobalt host. The corrected observed angular precessions were $\omega\tau_{184}(2^+) = 0.839 \pm 0.019$ and $\omega\tau_{186}(2^+) = 0.833 \pm 0.015$. The resulting hyperfine field on tungsten in cobalt, assuming $g_{184}(2^+) = 0.288 \pm 0.007$, is H_{hf}(CoW) = (−341 ± 12) kOe, and the resulting g factor of the first excited state of ^{186}W, determined relative to $g_{184}(2^+)$ in the cobalt host, is $g_{186}(2^+) = 0.358 \pm 0.021$. Agreement between $g_{184}(2^+)$ obtained from using a nickel host and $g_{186(2^+)}$ obtained using a cobalt host was very good, and a weighted average of these two independent measurements gives $g_{186}(2^+) = 0.361 \pm 0.018$. Target temperature measurements as a function of beam current were also performed. The observed trend of g with increasing A is not compatible with present theories. (auth)

14300 COULOMB EXCITATION OF ^{152}Sm AND ^{162}Dy BY ^{16}O. Lee, I.Y.; Saladin, J.X. (Nuclear Physics Laboratory, University of Pittsburgh, Pittsburgh, Pennsylvania 15213). Phys. Rev. C 9: No. 6, 2406-2410 (June 1974).

Coulomb excitation experiments on ^{152}Sm and ^{162}Dy by 48 MeV ^{16}O particles were performed at 110, 120, and 140° with 50-keV energy resolution. The B(E2, $2^+ \rightarrow 4^+$) and the reduced E2 matrix element $\langle 4^+ \| \mathcal{M}(E2) \| 4^+ \rangle$ were deduced from the excitation probabilities by using the quantum-mechanical coupled-channels code ROSA. The results are: B(E2, $2^+ \rightarrow 4^+$) = 1.87 ± 0.13 e^2b^2 $\langle 4^+ \| \mathcal{M}(E2) \| 4^+ \rangle$ = −3.4 ± 1.9 eb for ^{152}Sm, and for ^{162}Dy B(E2, $2^+ \rightarrow 4^+$) = 2.93 ± 0.20 e^2b^2, $\langle 4^+ \| \mathcal{M}(E2) \| 4^+ \rangle$ = −5.5 ± 3.6 eb. These values agree with the rigid rotator relation within the experimental uncertainties. (auth)

14301 ELASTIC SCATTERING OF 7.9-MeV PHOTONS FROM ^{181}Ta. Kahane, S.; Moreh, R. (Nuclear Research Center, Negev, Beer-Sheva, Israel). Phys. Rev. C 9: No. 6, 2384-2390 (June 1974).

Differential cross sections for elastic scattering of 7.9-MeV photons from ^{181}Ta have been measured at angles ranging from 25 to 140°. These results and previously measured differential cross sections from ^{238}U and ^{232}Th are compared with theoretical predictions taking into account Rayleigh scattering, nuclear Thomson scattering, nuclear resonance scattering, and Delbruck scattering. It is shown that at this energy the forward elastic scattering at angles ≲75° is due almost entirely to Delbruck scattering. The experimental results were found to deviate systematically from predicted values throughout most of the angular range. A striking agreement with theory was obtained only after excluding the contribution of the real part of the Delbruck scattering amplitude. (auth)

14302 NEUTRON STRENGTH FUNCTIONS OF NUCLEI IN THE DEFORMED REGION. Siddappa, K.; Murty, M.S.; Rao, J.R. (Laboratories for Nuclear Research, Andhra University, Waltair, India). Ann. Phys. (N.Y.) 83: No. 2, 355-366 (Apr 1974).

P-wave neutron strength functions of 21 nuclei, in the rare-earth and deformed region 138 < A < 202, have been extracted from the average capture cross sections measured using Sb-Be photoneutrons and activation technique. S-wave neutron contribution is computed using the s-wave resonance parameters available in literature and subtracted out from the measured total capture cross section to yield the p-wave neutron capture contribution from which the p-wave neutron strength functions are extracted. Present results are found to be in general agreement with the values reported in literature. The experimental p-wave neutron strength functions are also compared with the theoretical predictions based on the different versions of the optical model potential, and qualitative agreement is observed with the deformed optical model theory of Buck and Perey. Strong evidence for shell structure effects is also noticed. (auth)

Nuclear Properties and Reactions, 190 ≤ A ≤ 219

Refer also to abstracts 14208, 14286, 14302, 14305, 14347, 14360, and 14362.

14303 (INIS-mf-1243) FIRST-FORBIDDEN NON-UNIQUE ORBITAL ELECTRON CAPTURE. Studied by Means of an Internal Source Method. Goverse, S. C. (Vrije Universiteit, Amsterdam (Netherlands). Natuurkundig Lab. 29 Jun 1973. 107p. INIS.

Thesis.

The theory of β decay applied directly to the nuclear part of the electron capture process is reviewed. The accurate experimental electron capture ratios up till 1973 have been compared with the theoretical calculations. From this comparison it is suggested that correlation effects between the orbital electrons are the origin of the observed discrepancies. The electron capture ratios in the decays of ^{195}Au, ^{132}Cs and ^{206}Bi have been measured using the internal source method. The results have been taken into account in the discussion of the first-forbidden non-unique electron capture ratios. The growing and shaping of the source crystals are described. The electron capture branching ratios and several L/K and M+../L capture ratios of ^{196}Au have been measured. The atomic electron capture transition energy Q_{EC} and the cross-over decay probability of the 130-keV state have been calculated and discussed. The β^+ decay, the L/K capture ratio and the K/β^+ ratio of ^{132}Cs have been measured. The Q_{EC} value has been deduced from the K/β^+ ratio. All quantities are discussed. The L/K and M/L capture ratios of three levels of ^{206}Bi have been measured and deduced. The Q_{EC} value has been deduced from the L/K capture ratios and is discussed. (33 figures, 9 tables, 230 references) (INIS)

14304 HIGH-SPIN STATES AND CORIOLIS-DECOUPLED BANDS IN $^{190-194}$Hg. Beuscher, H.; Davidson, W.F.; Lieder, R.M.; Neskakis, A. (Institüt für Kernphysik, Kernforschungsanlage Jülich, D-517 Jülich, West Germany); Mayer-Böricke, C. Phys. Rev. Lett. 32: No. 15, 843-845 (15 Apr 1974).

Ground-state bands up to 8$^+$ and negative-parity bands, in one case up to 15$^-$, have been established in ^{190,192,194}Hg using (α,xn) reactions. Corresponding bands have been observed in ^{191,193}Hg and are interpreted as Coriolis-decoupled bands. (auth)

14305 PAIRING CORRELATIONS IN ^{210}Po AND ^{206}Pb AND α DECAY OF ^{210}Po. Kadmenskii, S. G.; Rybak, K. S. (Voronezh State Univ., USSR). Yadern. Fiz.; 19: No. 5, 971-978(May 1974). (In Russian).

The two-body two-time Green function equation in the system magic ±2 nucleons was used to obtain the ground state wave functions for the nuclei ^{210}Po and ^{206}Pb. The one-body basis included 16 hole and 21 particle subshells for ^{210}Po and 22 hole and 8 particle subshells for ^{206}Pb. The effect of expanding of the one-body basis and of the ground state correlations to ^{210}Po and ^{206}Pb ground state wave functions was studied. The ratio of the α-decay width for ^{210}Po with pairing of nucleons to the α-decay width treated in the simple shell model (i. e. a theoretical amplification coefficient) was calculated. It is found that the value $\kappa^{Theor} = 146$ is essentially higher than the value of a similar coefficient ($\kappa^{Theor} \approx 10$) calculated earlier with a limited shell basis and without ground state correlations. The closure relations of the used one-body basis were studied. (auth)

14306 K-SHELL AUTOIONIZATION IN THE BETA DECAY OF ^{203}Hg. Bond, A.; Gupta, O.P.; Zide, A. (Brooklyn College of the City University of New York, Brooklyn, New York 11210). Phys. Rev. C 9: No. 4, 1529-1532 (Apr 1974).

K-shell autoionization has been observed in the β decay of ^{203}Hg. The intensity of Tl K x rays was measured in coincidence with 279-keV γ rays from ^{203}Tl. The coincidence technique allowed a separation of auto-ionization x rays from internal-conversion x rays and simplified the normalization of the K-shell auto-ionization probability P_K. The experimental value of P_K obtained was $(1.1\pm0.35) \times 10^{-5}$, in good agreement with the theoretical prediction of Law and Campbell. (auth)

14307 ANGULAR-CORRELATION MEASUREMENTS OF SMALL MULTIPOLE ADMIXTURES IN GAMMA-RAY TRANSITIONS IN ^{207}Pb. Kaplan, M.; Wilson, E.J. (Carnegie-Mellon University, Pittsburgh, Pennsylvania 15213). Phys. Rev. C 9: No. 4, 1653-1656 (Apr 1974).

Precise angular-correlation measurements have been made on the 1770-570-keV and 1063-570-keV γ-ray cascades in ^{207}Pb. By using energy-gated timing analysis and obtaining good counting statistics at many angles, we have derived angular-correlation coefficients with significantly smaller uncertainties than previously reported. Data for the highly anisotropic 1063-570-keV correlation confirm the presence of a small E5 admixture in the predominantly M4 (13/2+ → 5/2-) transition. The nearly isotropic 1770-570-keV cascade exhibits considerably less anisotropy than found in earlier work and corresponds to a mixing of about 1% E2 into the (7/2- → 5/2-) M1 transition. (auth)

14308 RESONANCE FLUORESCENCE FROM THE 7.08-MeV STATE IN ^{208}Pb. Scholz, W.; Bakhru, H. (Department of Physics, State University of New York at Albany, Albany, New York 12222); Collé, R.; Li-Scholz, A. Phys. Rev. C 9: No. 4, 1568-1573 (Apr 1974).

The Doppler-broadened 7.12-MeV transition from the ^{19}F(p, $\alpha\gamma$)^{16}O reaction has been used to fluoresce resonantly a level at 7.084 ± 0.002 MeV in ^{208}Pb. A spin value of J = 1 has been assigned by measuring the intensity of the scattered radiation at average scattering angles of 90 and 130°. From a study of the intensity growth of the scattered radiation with increasing scatterer thickness (production experiment), the following level parameters were extracted: integrated scattering cross section $\int\sigma_s dE = 2.07 \pm 0.18$ MeV mb, maximum absorption cross section $\sigma_A^{max} = 85_{-31}^{+36}$ b, total level width $\Gamma = 26_{-12}^{+35}$ eV, and partial width for the ground-state transition $\Gamma_0 = 16_{-4}^{+6}$ eV. (auth)

14309 TWO-PROTON-TRANSFER REACTIONS ^{208}Pb(^{12}C, ^{10}Be)^{210}Po AND ^{208}Pb(^{16}O, ^{14}C)^{210}Po. Becchetti, F.D.; Kovar, D.G.; Harvey, B.G.; Hendrie, D.L.; Homeyer, H.; Mahoney, J.; von Oertzen, W.; Glendenning, N.K. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). Phys. Rev. C 9: No. 4, 1543-1567 (Apr 1974).

Levels in ^{210}Po have been investigated using the two-proton-transfer reactions (^{12}C, ^{10}Be) and (^{16}O, ^{14}C) on ^{208}Pb at incident energies E(^{12}C) = 78 MeV and E(^{16}O) = 104 and 140 MeV. Reaction products were identified and energies measured with a magnetic spectrometer and a focal-plane resistive-wire proportional counter. Many levels in ^{210}Po were observed up to an excitation energy of about 8 MeV. The results have been analyzed using distorted-wave Born approximation, and shell-model wave functions for levels in ^{210}Po have been tested. The 0$^+$ → 0$^+$(g.s.) transition is enhanced by a factor ~8 compared with the expected strength for a pure $(\pi h_{9/2})^2$ 0$^+$ configuration for ^{210}Po(g.s.). The dependence of the cross sections on projectile and target structure is discussed. (auth)

14310 ^{208}Pb(α,α)^{208}Pb SCATTERING NEAR THE COULOMB BARRIER. Hudson, G.M.; Davis, R.H. (Physics Department, The Florida State University, Tallahassee, Florida 32306). Phys. Rev. C 9: No. 4, 1521-1524 (Apr 1974).

Differential cross sections for the elastic scattering of α particles by ^{208}Pb have been measured over the laboratory energy range 16.0 to 25.5 MeV in 0.5-MeV steps and over the laboratory angle range of 30 to 170° in 5° steps. A unique real potential of 35±3 MeV is found in an optical-model analysis with $r_0 = 1.22$ fm in $R = r_0(A_1^{\frac{1}{3}} + A_2^{\frac{1}{3}})$ and a=0.57 fm. Uniqueness is expected for scattering in the vicinity of the Coulomb barrier once size parameters are fixed. No discrete ambiguities are found over the energy range investigated consistent with a square-well R-matrix model, but they may exist at higher energies. (auth)

14311 COLLECTIVE MULTIPOLE EXPANSION OF THE INELASTIC SCATTERING CONTINUUM. Lewis, M.B. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). Phys. Rev. C 9: No. 5, 1878-1881 (May 1974).

The differential cross sections for the high-energy inelastic scattering continuum are estimated by a direct-reaction model. The amplitudes for the expected collective multipoles were obtained from sum rules. An approximation method was applied to estimate an infinite multipole expansion. It was found that most of the relatively high-energy continuum cross sections in the (p, p') reaction could be accounted for by this collective multipole model. The theoretical angular distribution of the high-energy continuum in this model is in reasonable agreement with measured cross sections over the entire angular region studied. (auth)

14312 POSSIBLE MEASUREMENT OF THE VACUUM POLARIZATION IN HEAVY-ION SCATTERING. Rafelski, J.; Klein, A. (Department of Physics, University of Pennsylvania, Philadelphia, Pennsylvania 19104). Phys. Rev. C 9: No. 5, 1756-1759 (May 1974).

A measurement of the vacuum polarization potential in nonrelativistic elastic heavy-ion scattering is suggested. We find that in a typical sub-Coulomb barrier event enough momentum is transferred from the projectile to the target nucleus to make the high-q^2 behavior of the photon propagator observable. The elastic cross section is increased in a typical case by 2.5% above the Rutherford value. Only relative measurements are needed. (auth)

14313 NEUTRON-INDUCED GAMMA-RAY PRODUCTION IN ^{208}Pb. Nellis, D.O.; Morgan, I.L. (Texas Nuclear Corporation, Austin, Texas 78757); Hudspeth, E.L. Phys. Rev. C 9: No. 5, 1972-1977 (May 1974).

The cross section for γ-ray emission associated with inelastic scattering of neutrons in the ^{208}Pb(n, n'γ)^{208}Pb reaction has been measured at several angles for neutron energies between 3.1 and 5.25 MeV. The experimental data have been compared with calculations based on the Satchler formalism, with allowance for width-fluctuation

corrections. Agreement for the 2.61-MeV γ ray is excellent throughout. The experimentally observed cross sections for the other γ rays were generally 30 to 50% below the theoretical values, except for the 0.583-MeV γ ray, for which the observed values were well above the theoretical values. Resolution of several γ-ray peaks with a Ge(Li) detector has led to a modified level scheme for ^{208}Pb. (auth)

14314 NONALIGNMENT OF THE MAGNETIC HYPERFINE FIELD OF Ir IN Fe. Krane, K.S. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720); Steyert, W.A. Phys. Rev. C 9: No. 5, 2063-2066 (May 1974).

Previous discrepancies in the reported values of the nuclear magnetic dipole moment of the 171-keV level of ^{191}Ir measured by nuclear orientation and nuclear magnetic resonance techniques are resolved by an interpretation in terms of nonalignment of the static magnetic hyperfine field of Ir in Fe with the applied field. The angle between the applied and hyperfine field directions is deduced to be 15°. Other possible sources of the discrepancies in the reported moments are shown to be negligible. The best value of the moment is believed to be $\mu = (6.03 \pm 0.04)\ \mu_N$ measured by Eska et al. using NMR techniques. (auth)

14315 INTERACTION OF ALPHA PARTICLES IN THE LEAD REGION NEAR THE COULOMB BARRIER. Barnett, A.R.; Lilley, J.S. (J. H. Williams Laboratory of Nuclear Physics, University of Minnesota, Minneapolis, Minnesota 55455). Phys. Rev. C 9: No. 5, 2010-2027 (May 1974).

The (α, n) cross section on ^{208}Pb and ^{209}Bi has been measured between 16 and 24 MeV by observing the α activity of the residual nuclei ^{211}Po and ^{212}At. The relative yields to both the ground and metastable states of each residual nucleus were obtained and new half-life determinations have been made for these states. The absolute yield was measured at 20 and 22 MeV to normalize the relative data. Below the (α, 2n) threshold, σ (α, n) constitutes most of the total reaction cross section, and the (α, n) data, together with accurate elastic scattering measurements at 19, 20, and 22 MeV are reproduced well by a six-parameter optical model. The fits are sensitive to the reaction cross-section data, and serve to define the magnitude and shape of the real potential at a radial distance of about 11 fm. The real potential in this region dominates the interaction at the present energies. The imaginary potential is relatively small; it is not well determined and serves only to absorb those waves which penetrate the real potential. The real potential obtained is interpreted in terms of an α-folding model using a free α-nucleon two-body force. The potential near the peak of the Coulomb barrier is determined primarily by the target matter density near 9 fm, where it is approximately 1% of its value at the center of the nucleus. Implications concerning the relative distributions of target neutrons and protons are discussed. (auth)

14316 INTERNAL CONVERSION OF TWO LOW ENERGY TRANSITIONS IN ^{195}Au. Spalek, A.; Dragoun, O. (Nuclear Physics Inst., Rez, Czech.). Czech. J. Phys.; 24: No. 2, 161-170 (1974).

Conversion electron spectra of the low energy transitions in ^{195}Au taken with a magnetic spectrometer were analyzed numerically. Derived conversion line intensities were found to agree with recent calculations of internal conversion coefficients for the subshells, L_1, M_1, N_1 and O + P. Transition energies and multipolarities were determined to be 61.35 ± 0.06 keV [M1 + (15.7 ± 0.6)% E2] and 56.60 ± 0.06 keV [pure E3]. A description is given of the employed computer program DECOS 1 which makes use of an analytical function to express the conversion line shape. (auth)

14317 ^{208}Pb(p, d)^{207}Pb AND ^{48}Ca(d, t)^{47}Ca REACTIONS NEAR THE COULOMB BARRIER. Friedman, E.; Nir, D.; Suraqui, D.; Tuchman, Y. (The Racah Institute of Physics, the Hebrew University, Jerusalem, Israel). Phys. Rev. C 9: No. 6, 2340-2345 (June 1974).

The ^{208}Pb(p, d)^{207}Pb reaction to the $3p_{1/2}$, $2f_{5/2}$, and $3p_{3/2}$ single-hole states was studied at energies below the Coulomb barrier. The ^{48}Ca(d, t)^{47}Ca reaction to the $1f_{7/2}$ single-hole state was studied near the Coulomb barrier. Distorted-wave Born approximation analyses provided values for the root-mean-square radii of the orbitals of the picked-up neutrons. These values are in agreement with results obtained from other reactions and from nuclear-structure calculations, but disagree with values based on analyses of Coulomb displacement energies. (auth)

14318 COMPLEX NONLOCAL OPTICAL POTENTIAL FOR NEUTRON SCATTERING FROM ^{208}Pb. Lev, A.; Beres, W.P. (Wayne State University, Detroit, Michigan 48202); Divadeenam, M. Phys. Rev. C 9: No. 6, 2416-2434 (June 1974).

A nonlocal energy-dependent imaginary optical potential is calculated for neutron scattering from ^{208}Pb in the intermediate structure model with weak particle-vibration coupling. The energy range studied is 0-12 MeV and the partial waves considered are $l = 0 - 4$. The corresponding contribution to the real potential has also been obtained and is relatively small; this potential is presented for s-waves. The imaginary potential is used to calculate the absorption cross section in this energy range for each partial wave. Both compound nucleus and inelastic contributions to the potential and the absorption cross section are included. Below 5 MeV compound nucleus contributions are dominant. Above this energy inelastic excitations based on single particle resonances and compound nucleus states based on giant resonances contribute, with the former being more significant. A comparison of the calculated absorption to experiment for s, p, d, and f waves is made below the inelastic threshold of 2.6 MeV. The agreement, except for p waves, is quite good in terms of the number of resonances and other significant details of the cross section. The calculated absorption cross sections up to 12 MeV are compared to the results from a phenomenological local surface peaked imaginary potential. The nonlocal potential is also surface peaked and the details of its radial behavior for an arbitrary energy are given in a contour plot. (auth)

14319 TWO-STEP SHELL MODEL CALCULATION OF ^{208}Po. True, W.W. (Physics Department, University of California, Davis, California 95616); Ma, C.W. Phys. Rev. C 9: No. 6, 2275-2288 (June 1974).

The low lying levels ^{208}Po have been calculated by a two-step shell model calculation which uses the vector-coupled states from ^{206}Pb and ^{210}Po as a basis. The calculated and experimental energy levels are in good agreement with each other. (auth)

14320 DETERMINATION OF THE ISOSPIN DEPENDENCE OF THE EFFECTIVE PARTICLE-HOLE INTERACTION FROM CONSISTENCY RELATIONS. Nopre, H. (CNSR, Strasbourg); Werner, E. Z. Phys.; 267: No. 2, 165-168(Mar 1974).

A consistency relation connected with the isospin dependence of the effective particle-hole interaction is derived. This relation is applied to the nucleus ^{208}Pb and permits the determination of one parameter of the effective interaction. (GE)

14321 CALCULATION OF THE PARTICLE-PHONON MULTIPLETS IN ^{209}Bi. Zawischa, D. (Technische Univ., Hanover). Z. Phys.; 266: No. 2, 117-121(Jan 1974).

The multiplet energies are calculated using density-dependent effective forces of the type proposed by Migdal. Very good agreement is obtained in the case of the septuplet. For the decuplet, the $(2j + 1)$ rule for the cross sections is shown to be incorrect. The data obtained on the decuplet agree well with experiment if a new spin assignment is adopted. Results on the $h_{9/2} \times 4^-$, $h_{9/2} \times 5_2^-$ and $f_{7/2} \times 3^-$ multiplets are also given. (GE)

Nuclear Properties and Reactions, A ≥ 220

Refer also to abstracts 13864 and 14301.

14322 (JINR-P6-7856) EXPERIMENTS ON SEARCH IN NATURE FOR SPONTANEOUSLY FISSIONING NUCLIDES OF SUPERHEAVY ELEMENTS. III. Search for Superheavy Elements in Iron-Manganese Nodules. Flerov, G. N.; Vyropaev, V. Ya.; Getskin, L. S.; Popeko, A. G.; Skobelev, N. K.; Ter-Akop'yan, G. M ; Tsyb, P. P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1974. 16p. Dep. NTIS (US Sales Only) $4.00. (In Russian).

Searches were made for superheavy elements in iron-manganese nodules. The products sublimated from the nodules and the products chemically enriched in the heavy elements were investigated. For the products studied limiting values were obtained for the half-life-to-concentration ratio for heavy analogs of Hg, Tl, Pb, and Bi. (auth)

14323 ELECTROMAGNETIC PROPERTIES OF THE EXCITED STATES IN ^{239}Pu. Patel, S.B.; Agnihotry, A.P.; Tandon, P.N.; Gopinathan, K.P. (Tata Institute of Fundamental Research, Bombay-400005, India). Phys. Rev. C 9: No. 4, 1515-1520 (Apr 1974).

The electromagnetic properties of the 285.5- and 391.6-keV levels in ^{239}Pu populated in the β^- decay of ^{239}Np have been investigated. The half-lives of these levels have been measured using the delayed-coincidence technique to be $T_{1/2}(285.5) = 1.12 \pm 0.05$ nsec and $T_{1/2}(391.6) = 192 \pm 6$ nsec. The multipole mixing ratios of the 106.2-, 209.8-, 228.2-, and 277.6-keV transitions have been determined from γ-γ angular-correlation measurements to be $\delta(M2/E1)_{106.1} = -0.05 \pm 0.02$, $\delta(E2/M1)_{209.8} = -0.12 \pm 0.03$, $\delta(E2/M1)_{228.2} = -0.10 \pm 0.03$, and $\delta(E2/M1)_{277.6} = +0.17 \pm 0.02$. The mean precession angle $\omega\tau$ for the 285.5-keV level, in an external magnetic field of 20 kG, is measured to be $\omega\tau = 0.166 \pm 0.037$. From this the value of $g\beta$ is obtained to be $g\beta = -1.06 \pm 0.25$. The paramagnetic correction factor β for the Pu^{4+} state is estimated to be 2.16 in the limit of L-S coupling. Using this the g factor of the 285.5-keV level has been deduced to be -0.49 ± 0.11. The

magnetic moment and the reduced transition probabilities have been compared with the theoretical estimates based on Coriolis-coupling calculations. (auth)

14324 FISSION OF DOUBLY EVEN ACTINIDE NUCLEI INDUCED BY DIRECT REACTIONS. Back, B.B.; Hansen, O. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87544); Britt, H.C.; Garrett, J.D. Phys. Rev. C 9: No. 5, 1924-1947 (May 1974).

Fission probability distributions have been measured by (t, pf), (t, αf), (t, tf), (p, pf), (^{3}He, df) and (^{3}He, αf) reactions with bombarding energies of 15, 16, 20, 22.5, 24, and 24 MeV, respectively. Using targets of ^{230,232}Th, ^{231}Pa, ^{234,236,238}U, ^{237}Np, ^{240,242}Pu, ^{243}Am, and ^{248}Cm the fission decay of ^{230,232,234}Th, ^{232,236,238,240}U, ^{238,242,244}Pu, and ^{244,248,250}Cm was studied. Subbarrier vibrational resonances were observed for ^{234}Th, ^{236,238,240}U, ^{242}Pu, and ^{250}Cm. The results are analyzed with a statistical model which involves resonant penetration of the double-humped fission barrier. Estimates of the heights and curvature of the two peaks in the fission barrier are obtained for Th, U, Pu, and Cm isotopes and these values are compared with various theoretical calculations. (auth)

14325 NEW DETERMINATION OF THE ^{233}U SPECIFIC ACTIVITY AND HALF-LIFE. Jaffey, A.H.; Flynn, K.F.; Bentley, W.C.; Karttunen, J.O. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). Phys. Rev. C 9: No. 5, 1991-2000 (May 1974).

A new determination of the ^{233}U specific activity has been made using a method developed for measuring the longer-lived uranium isotopes. Samples prepared by molecular plating were counted in an intermediate-geometry α proportional counter with a flat pulse-height plateau. For each sample, the small amount of residual non-plated uranium was evaluated by counting in a 2π counter. Energy analysis with a silicon-junction detector allowed accurate measurement of the small amount of activity not ascribable to ^{233}U and ^{234}U. The ^{234}U activity was corrected for by calculation from the mass-spectroscopically-measured isotopic concentration. The specific activity was measured as 21405 ± 20-dis/min μg ^{233}U, corresponding to a half-life of (1.5911 ± 0.0015) × 10^5 yr. The quoted error is statistical (standard error of the mean), based upon observed scatter of the data. (auth)

14326 X RAYS FOLLOWING THE ALPHA DECAY OF ^{231}Pa. de Pinho, A.G. (Department of Physics, Pontifícia Universidade Católica do Rio de Janeiro, Brasil); Auler, L.T.; da Silva, A.G. Phys. Rev. C 9: No. 5, 2056-2059 (May 1974).

More detailed information is presented concerning the L and K x-ray spectra due to internal conversion of the electromagnetic transitions following the α decay of ^{231}Pa. Some of the difficulties discussed in de Pinho et al. [Phys. Rev., C; 2: 572(1970)] are clarified. (auth)

14327 SEARCH FOR LOW-YIELD PRODUCTS IN THE NEUTRON-INDUCED HIGHLY ASYMMETRIC FISSION OF URANIUM. Rao, V.K.; Bhargava, V.K.; Marathe, S.G.; Sahakundu, S.M.; Iyer, R.H. (Radiochemistry Division, Bhabha Atomic Research Centre, Trombay, Bombay-400085, India). Phys. Rev. C 9: No. 4, 1506-1514 (Apr 1974).

The results of investigations aimed at defining the nature of mass distribution in the reactor neutron-induced highly asymmetric binary fission of natural, depleted, and enriched uranium are presented. Fission yields of mass chains 66, 67, 72, 77, 161, 172, 175, 177 were determined relative to ^{99}Mo using radiochemical methods. Upper limits for the yields of ^{183}Ta and ^{199}Au were also set to see the trend of mass distribution beyond A = 177. As expected the yields of highly asymmetric products in the region A < 70 and A > 161 are sensitive to the excitation energy of the fissioning nucleus, a trend observed in symmetric fission. Computer extrapolation of the yields up to A = 180 on the heavier side and A = 60 on the lighter side indicates that both wings of the mass yield curve cannot be represented by a single Gaussian, thereby disturbing the complementarity of the mass yield curve in the highly asymmetric region. The relatively higher yields for mass regions around A = 67 and 177, together with the upper limits for A = 183 and 199 in the reactor neutron fission of ^{238}U, tend to suggest the possibility of shoulders in the low-yield wings of the mass yield curve. (auth)

14328 SYMMETRIC FISSION OF ^{257}Fm. Fong, P. (Department of Physics, Emory University, Atlanta, Georgia 30322). Phys. Rev. C 9: No. 6, 2448-2450 (June 1974).

The unusual properties of ^{257}Fm fission are explained by the statistical theory of fission in the same manner as the usual properties of fission of the other fissioning nuclides are explained. (auth)

14329 MEASUREMENT OF THE g FACTOR FOR THE 1.1-μsec SHAPE ISOMERIC STATE IN ^{237}Pu. Kalish, R.; Herskind, B.; Pedersen, J.; Shackleton, D.; Strabo, L. (The Niels Bohr Institute, University of Copenhagen, Copenhagen, Denmark). Phys. Rev. Lett. 32: No. 18, 1009-1012 (6 May 1974).

The spin precession of the 1.1-μsec shape isomeric state in ^{237}Pu has been measured by the perturbed angular correlation method. From a measurement of the spin rotation frequency as a function of temperature of the target, the paramagnetic correction factor β has been determined to be in agreement with the theoretical value of 2.86 at room temperature for a 4^+ ionic state. The deduced value for g is +0.14 ± 0.02. (auth)

14330 ELECTRIC MONOPOLE TRANSITION IN ^{228}Th. Devare, S.H.; Devare, H.G. (Tata Institute of Fundamental Research, Bombay, India). Phys. Rev. C 9: No. 6, 2297-2299 (June 1974).

The 184.5-keV transition from the 1153.6-keV level of ^{228}Th excited in the decay of ^{228}Ac is shown to be (93 ± 2) % E0 in character from K/L and L_I/L_{II} conversion ratios. The half-life of the 1153.6-keV level is measured to be $T_{1/2}$ = 0.29 ± 0.02 ns from β-γ delayed coincidence measurements. From this, the value of the monopole strength parameter is deduced to be ρ = 0.11 ± 0.02. (auth)

14331 PARAMETERS OF NEUTRON RESONANCES IN ^{238}U. Mewissen, W. L. Louvain, Belgium; Univ. Louvain (1974). 61p. (In Dutch). Centre d'Etudes de l'Energie Nucleaire, Mol, Belgium. Thesis.

The resonance parameters of ^{238}U for neutrons with energies up to 1.8 keV are determined by the mean capture width and the S-wave strength function S_0. We measured 99 levels and thus reduced the error on S_0. In order to minimize errors in the determination of the mean capture width $\bar{\Gamma}_\gamma$, we measured partial as well as total cross sections. The measured values have been compared to theoretical models, and the sub-threshold fission has been studied. (BE)

Nuclear Theory

Refer also to abstracts 13406, 13868, 14215, 14294, and 14311.

14332 (AREAEE-179) LEGENDRE EXPANSION AND COORDINATE TRANSFORMATION. Comsan, M. N. H. (Atomic Energy Establishment, Cairo (Egypt)). 1973. 27p. Dep. NTIS (US Sales Only) $4.50.

The program code "NCTR" is given. It is an automatic computer program in FORTRAN-IV language for the calculation of center of mass transformation and Legendre polynomial expansion of nuclear reaction cross sections. The program is written for the use on IBM-1130 computer, but it can be used on other computers core storage of which is not less than 11 K. The complete program is contained listing along with sample input to and output from the program. Corrections and suggestions for program modification from the users will be greatly criticized. (auth)

14333 (CONF-740633-1) ELECTRONIC STATES OF IONS RECOILING INTO VACUUM AND GASES. Datz, S. (Oak Ridge National Lab., Tenn. (USA)). 1973. 41p. Dep. NTIS $5.25.

From international conference on hyperfine interactions studied in nuclear reactions and decay; Uppsala, Sweden (10 Jun 1974).

In the study of hyperfine interactions of nuclear states created by nuclear reaction or Coulomb excitation the recoiling ion undergoes a series of collisions in which electrons are captured and lost and in which electronic excitation and deexcitation take place. A knowledge of the electronic states of the ion on a time scale commensurate with the lifetime of the nuclear states (1-100 psec) is vital to the understanding of the field at the nucleus. Atomic collision processes in dilute and dense media are discussed in terms of charge changing and excitation of both inner and outer shell electrons and the application to some perturbed angular correlation measurements are given. (auth)

14334 (IFA-RN-50-1974) MECHANISM FOR INDUCED FISSION WITH THERMAL AND FAST NEUTRONS ON ^{235,236}U AND ^{239}Pu. Cristu, M. (Institutul de Fizica Atomica, Bucharest (Romania)). 1974. 71p. (In Rumanian). Dep. NTIS (US Sales Only) $6.75.

The mechanism of fission induced by thermal and fast neutrons in ^{235}U, ^{238}U and ^{239}Pu is reviewed from a phenomenological point of view. The mass, charge and energy distributions of fission fragments are examined and regularities in terms of mass, charge and neutron numbers are outlined. Emission of prompt neutron and gamma rays is studied in correlation with the mass and energy distributions of fission fragments. A special attention is given to the correlation between the emission of prompt neutrons and the excitation of compound nucleus. The last section is devoted to delayed neutron and gamma ray emission, and a discussion of delayed neutron precursors is given. (auth)

14335 (JINR-P2-7869) SPACE-TIME DEVELOPMENT OF THE HADRON MULTIPLE PRODUCTION PROCESS. Kalinkin, B. N.; Shmonin, V. L. (Joint Inst. for Nuclear Research,

Dubna (USSR). Lab. of Theoretical Physics). 1974. 22p. (In Russian). Dep. NTIS (US Sales Only) $4.25.

A possible use of nuclear medium for testing the hypothesis about the realization of cluster states in the multiple production process is investigated. (auth)

14336 (JINR-P4-7862) MATRIX ELEMENTS OF THE MULTIPOLE OPERATORS IN THE CASE OF ROTATIONAL STATES WITH HIGH ANGULAR MOMENTA. Mikhailov, I. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 17p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

The parametrization of matrix elements of the multipole operators is given applicable to the case of rotational states with the high angular momentum quantum numbers. In particular, the matrix elements of the quadrupole charge distribution are considered. (auth)

14337 (NP-20030) SUM RULES IN THE RANDOM PHASE APPROXIMATION. Semenko, S. F. (AN SSSR, Moscow. Fizicheskij Inst.). 1974. 32p. (In Russian). Dep. NTIS (US Sales Only) $4.75.

Starting from the R. P. A. equations, the sum rules: $\sum[(O/F/N)(N/\Phi/O) + (-1)^{k+1}(O/\Phi/N)(N/F/O)]E_N^k$ for local single-particle operators F, Φ are obtained. The resulting formulas are those of the single-particle model with the effective single-particle operator $H_{effective} = H_{sp} + \Delta V$, standing in the commutators instead of the single particle Hamiltonian H_{sp}. The ΔV, which includes the residual interactions effect, depends on the spin and the isospin of the excitation. By utilizing the obtained sum rules, the electric multipole resonances energies are calculated, the optical anisotropy of the nucleus with the diffuse surface is estimated, the transition density sum rules and the equation for the collective coordinate are deduced. The sum rules: $\Sigma_N (O/F/N)E_N^k(N/\Phi/O)$ for the Tamm-Dankoff method are given. (auth)

14338 GENERALIZED ATTENUATION CORRECTION FACTOR FOR SCATTERING FROM CYLINDRICAL TARGETS. Mildner, D.F.R.; Carpenter, J.M.; Pelizzari, C.A. (University of Michigan, Department of Nuclear Engineering, Ann Arbor, Michigan 48105). Rev. Sci. Instrum. 45: No. 4, 572-575 (Apr 1974).

The attenuation correction factor is developed for scattering from a cylinder. The result applies for the case in which the attenuation coefficients Σ differ for incident and scattered radiation and for that in which radiation is incident or scattered obliquely from the cylinder axis. The result is related to one generated earlier for the case of scattering perpendicular to the axis and uses an improved approximation useful for slant thicknesses $\Sigma R/\cos\beta 2.0z$. (auth)

14339 PION CHARGE-EXCHANGE SCATTERING IN THE (3, 3) -RESONANCE REGION IN NUCLEI WITH A NEUTRON EXCESS. Adler, S.L. (Institute for Advanced Study, Princeton, New Jersey 08540). Phys. Rev. D 9: No. 7, 2144-2150 (1 Apr 1974).

We solve the multiple-scattering problem describing one-dimensional charge-exchange scattering in nuclear matter with a neutron excess, and use the solution to formulate models for lepton- and proton-induced production of pions in the (3, 3) -resonance region. (auth)

14340 NUCLIDIC MASS RELATIONSHIPS AND MASS EQUATIONS. Jänecke, J. (Department of Physics, Cyclotron Laboratory The University of Michigan, Ann Arbor, Michigan 48105); Behrens, H. Phys. Rev. C 9: No. 4, 1276-1291 (Apr 1974).

Generalized nuclidic mass relationships represent a link between mass equations and mass relationships. They are partial difference equations which can be used recursively. The quality of mass predictions, particularly for very neutron-rich or proton-rich nuclei, depends essentially on our knowledge of the effective neutron-proton interaction I_{np}. The transverse and longitudinal mass relationships of Garvey and Kelson which are special cases contain small systematic errors due to the assumed independence of I_{np} on the neutron excess or the nucleon number. Information about the dependence of I_{np} on T and A has been extracted from the experimental masses by a variety of χ^2 tests and was found in partial disagreement with macroscopic and microscopic theories. Several procedures have been devised to test theoretical expressions for I_{np} for their compatibility and consistency with the experimental masses. (auth)

14341 DEUTERON STRIPPING: A STUDY OF THE SUDDEN-APPROXIMATION THEORY WITHIN THE CONTEXT OF A SOLUBLE MODEL CONTAINING AN EXCITABLE NUCLEAR CORE. King, K. (Department of Theoretical Physics, University of Sydney, Sydney, New South Wales, Australia 2006); McKellar, B.H.J. Phys. Rev. C 9: No. 4, 1309-1328 (Apr 1974).

We test the validity of the sudden-approximation theory of deuteron stripping of Butler, Hawett, McKeller, and May (BHMM) by testing its predictions of final-state angular distributions and spectroscopic factors against those of an essentially soluble model of stripping reactions. This model has been constructed with an excitable nuclear core which therefore allows a calculation of the final-state spectroscopic factor to be made in advance. It is based on the solution of the Faddeev equation for multichannel separable s-wave two-body interactions between proton and neutron, proton and core, and neutron and core. There are two features which characterize BHMM; one is the sudden approximation and the other is use of intermediate neutron states of a special sort. Both these features give rise to difficulties. (auth)

14342 DYNAMIC TREATMENT OF THE MASS DISTRIBUTION IN FISSION. Pwu, L.C.; Castel, B. (Department of Physics, Queen's University, Kingston, Ontario, Canada). Phys. Rev. C 9: No. 4, 1650-1652 (Apr 1974).

The time-dependent Schrödinger equation in nuclear collective coordinates is solved to give the mass distribution in fission as a function of excitation energy. (auth)

14343 SENSITIVITY OF THE SMALL-ANGLE CHARGE-EXCHANGE POLARIZATION-TRANSFER REACTION TO SPIN-FLIP FORCES. Madsen, V.A. (Oregon State University, Corvallis, Oregon 97331); Anderson, J.D.; Brown, V.R. Phys. Rev. C 9: No. 4, 1253-1257 (Apr 1974).

We present a derivation of the zero-angle polarization transfer $K_{y'}(0^\circ)$ in charge exchange and inelastic scattering using direct-reaction theory with central and tensor spin-dependent forces. The energy dependence of the calculated polarization transfer is sensitive to the relative strengths of the spin-independent, central spin-spin, and tensor forces. Adjustment of the parameters of a purely central force cannot reproduce the calculated results for central-plus-tensor forces, giving rise to the hope that measurements of data of this type will allow one to distinguish between central spin-spin and tensor forces. Numerical results are presented for ^{15}N, ^{11}B, and $^{3}H(p,n)$ reactions. (auth)

14344 OFF-SHELL EFFECTS IN ELASTIC PION-NUCLEUS SCATTERING. Ernst, D.J.; Shakin, C.M.; Thaler, R.M. (Department of Physics, Case Western Reserve University, Cleveland, Ohio 44106). Phys. Rev. C 9: No. 4, 1370-1373 (Apr 1974).

For elastic scattering of pions from nuclei in the energy region of the (3,3) resonance, the effects of the binding of the target nucleons are shown to be important in the calculation of the pion-nucleus optical potential. The size of these binding effects are estimated for the case in which the free pion-nucleon scattering amplitude is represented by a separable form. (auth)

14345 UNITARITY AND OFF-SHELL EFFECTS IN THE IMPULSE APPROXIMATION. Ernst, D.J.; Shakin, C.M.; Thaler, R.M. (Department of Physics, Case Western Reserve University, Cleveland, Ohio 44106). Phys. Rev. C 9: No. 4, 1374-1384 (Apr 1974).

For elastic scattering of a particle from a finite many-body target, the procedure of eliminating the two-body potential in favor of a two-body scattering matrix is examined. It is shown that the theory of Kerman, McManus, and Thaler leads to unitary relations which are not of a particularly convenient form. A simple procedure which identifies the appropriate off-shell scattering matrix to be used in the impulse approximation is presented. The projection operator technique is employed to define an optical potential and then, in a truncated Hilbert space, a relation similar to a two-body Low equation is used to identify the appropriate two-body T matrix. With this latter procedure the unitarity relations are maintained in a form which allows them to be used as a guide to the validity of the impulse approximation. (auth)

14346 INTERMEDIATE-ENERGY PION-NUCLEUS SCATTERING ASSUMING A SEPARABLE FIXED-SCATTERER PION-NUCLEON INTERACTION. Piepho, M.G.; Walker, G.E. (Department of Physics, Indiana University, Bloomington, Indiana 47401). Phys. Rev. C 9: No. 4, 1352-1369 (Apr 1974).

A formal discussion of the optical potential due to Foldy and Walecka is extended to include spin and isospin degrees of freedom and projectile relativistic kinematics. The formalism is applied to intermediate-energy pion-nucleus elastic scattering. Assuming an infinitely heavy nucleon mass, we obtain a fixed-scatterer separable-potential parametrization of the two-body pion-nucleon scattering data in the laboratory system. This effective two-body potential is used in a consistent manner as microscopic input in the many-body pion-nucleus elastic scattering problem. Using the approximations adopted by Foldy and Walecka, we obtain a pion-nucleus optical potential which is then applied to study pion elastic scattering from ^{12}C, ^{16}O, ^{28}Si, ^{32}S, and ^{40}Ca. Total cross-section and angular-distribution predictions for pion kinetic energies ~70-280 MeV are presented. Good agreement is obtained with the available experimental data on ^{12}C and ^{32}S. (auth)

14347 MACROSCOPIC ANALYSIS OF (p, n) REACTIONS. Kunz, P.D.; Rickertsen, L.D. (Nuclear Physics Laboratory, Department of Physics and Astrophysics, University of Colorado, Boulder, Colorado 80302); Hoffmann, G.W. Phys. Rev. C 9: No. 4, 1659-1661 (Apr 1974).

The extraction of the isovector part of the optical potential from nucleon–nucleus optical potentials is discussed when the optical potentials are energy-dependent. (auth)

14348 PARTIAL CONSERVATION OF AXIAL-VECTOR CURRENT AND NUCLEAR BETA DECAY. Holstein, B.R. (Department of Physics and Astronomy, University of Massachusetts, Amherst, Massachusetts 01002). Phys. Rev. C 9: No. 4, 1646-1649 (Apr 1974).

The disagreement pointed out by Armstrong and Kim between the elementary particle approach and the impulse-approximation predictions for $\Delta J^P=0$ nuclear β decay is examined from the point of view of the axial current operator. Naive theoretical predictions are found to be in disagreement with present data. (auth)

14349 ELECTROMAGNETIC CORRECTIONS TO ALLOWED NUCLEAR BETA DECAY. Holstein, B.R. (Department of Physics and Astronomy, University of Massuchusetts, Amherst, Massachusetts 01002). Phys. Rev. C 9: No. 5, 1742-1747 (May 1974).

Dominant Coulomb corrections to the spectral functions for allowed nuclear β transitions are calculated using the elementary particle approach. (auth)

14350 EXTENSION OF THE VARIABLE-MOMENT-OF-INERTIA MODEL TO LARGE VALUES OF ANGULAR MOMENTUM AND THE EXPLANATION OF THE s SHAPE OF THE $\mathcal{J}$ VS ω^2 CURVE. Goodman, A. L. (Lawrence Berkeley Laboratory, Berkeley, California 94720); Goswami, A. Phys. Rev. C 9: No. 5, 1948-1953 (May 1974).

We postulate a mixing of the states of the ground rotational band with those of an excited one, whose intrinsic excitation energy changes with angular momentum. This is shown to restore agreement with experiment for the variable-moment-of-inertia model up to all observed values of angular momentum. (auth)

14351 PHENOMENOLOGICAL DESCRIPTION OF NEW FEATURES OF ROTATIONAL SPECTRA. Mantri, A.N.; Sood, P.C. (Nuclear Physics Section, Department of Physics, Banaras Hindu University, Varanasi 221005, India). Phys. Rev. C 9: No. 5, 2076-2079 (May 1974).

It is shown that the energy expression as a cubic polynomial (CP) in spin I, in addition to giving an excellent fit to the excitation energies of the ground-band levels in all even-even nuclei, also reproduces a critical spin I_c beyond which the squared rotational frequency ω^2 decreases although the moment of inertia $\mathcal{J}$ keeps on increasing, thus resulting in back bending in $I-\omega^2$ plots. This feature is predicted to appear not only in well-deformed nuclei bu at quite low spins in nearly spherical nuclei as well. Further, the CP formula predicts the nuclear moment of inertia for the first 2^+ state to be smaller than that for the ground state for most of the hard rotors; correspondence of this characteristic with the shrinkage deduced from muonic atom studies and Mössbauer experiments is discussed. (auth)

14352 EXCHANGE CURRENTS AND THE FORM FACTORS OF NUCLEAR EXCITATIONS. Mekjian, A.Z. (Rutgers University, Department of Physics, New Brunswick, New Jersey 08904). Phys. Rev. C 9: No. 5, 2084-2085 (May 1974).

An evaluation of the effect of exchange currents on the momentum-transfer dependence of the inelastic form factor for nuclear isovector excitations, such as the dipole and monopole vibration, is given. It is found that departures from the hydrodynamic model prediction become important at $q \gtrsim 1$ fm^{-1}. (auth)

14353 ASPECTS OF THERMODYNAMIC CALCULATIONS OF SHELL CORRECTION ENERGIES. Das Gupta, S.; Radhakant, S. (Physics Department, McGill University, Montreal, Canada). Phys. Rev. C 9: No. 5, 1775-1779 (May 1974).

We demonstrate that the thermodynamic method of extracting shell correction energies is a reasonable one. Further, any pair of thermodynamic variables can be used. Approximations inherent in the method are looked at carefully. (auth)

14354 VARIATIONAL CALCULATION OF LIGHT NUCLEI USING NEARLY ORTHOGONAL FUNCTIONS. Reid, N.E.; Davison, N.E.; Svenne, J.P. (Department of Physics, University of Manitoba, Winnipeg, Manitoba, Canada, R3T 2N2). Phys. Rev. C 9: No. 5, 1882-1900 (May 1974).

A Hartree–Fock–like variational calculation which is specifically directed toward the treatment of axial and triaxial deformations in light nuclei is presented. By choosing Cartesian harmonic-oscillator wave functions to be the trial wave functions and taking the oscillator length parameters $b_x[=(\hbar/m\omega_x)^{1/2}]$, b_y, b_z in each major oscillator shell to be the variational parameters, the capacity for deformation is built into the wave functions from the outset and a substantial reduction in the calculational effort is achieved. These variational wave functions are not strictly orthogonal, but the effects of this approximation appear to be relatively unimportant. A realistic two-body effective interaction is employed which depends on the average density of the nucleus under consideration. It is constructed from nuclear matter theory and has been shown to contain the most important physical aspects of the Brueckner G matrix. The shapes of the intrinsic states of 4n nuclei are found to be more complicated than simple spheroids or ellipsoids, often exhibiting large hexadecapole moments. Ground-state properties including binding energies, rms charge radii, and multipole moments are calculated and found to be in accord with experimental results and earlier calculations. (auth)

14355 PARTICLE-HOLE INTERACTIONS AND VIBRATIONAL STATES. Chasman, R.R. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). Phys. Rev. C 9: No. 5, 1795-1800 (May 1974).

A method is presented for the treatment of particle–hole residual interactions that is both simple and extremely accurate. This method is compared with the random-phase approximation, Tamm–Dancoff approximation, and other approximations in the schematic model of Brown and the monopole model of Lipkin, Meshkov, and Glick. (auth)

14356 DISSIPATIVE CAPTURE IN HEAVY-ION FUSION. Davis, R.H. (Department of Physics, Florida State University, Tallahassee, Florida 32306). Phys. Rev. C 9: No. 6, 2411-2415 (June 1974).

Energy dissipation during sliding contact is discussed as a fusion limiting mechanism in heavy-ion collisions. A simple model yields a critical angular momentum for fusion in good agreement with the experimental trend of Natowitz after normalization. Estimates of the nuclear viscosity coefficient are in order of magnitude agreement with two available values. (auth)

14357 SURVEY ON THE NUCLEAR-MATTER PROPERTIES OF THE GRAZ POTENTIAL. Meunier, J.-P.; Plessas, W.; Pigeon, J.; Nahabetian, R. (Institut de Physique Nucléaire, Université Claude Bernard Lyon-I (Institut National de Physique Nucléaire et de Physique des Particules) 43, Bd du 11 Novembre 1918, 69621 Villeurbanne, France). Phys. Rev. C 9: No. 6, 2114-2124 (June 1974).

In this paper, we intend to deal with the nuclear matter properties exhibited by the separable nucleon–nucleon potential recently proposed by the Graz group. This model was the basis of the first-order perturbation theory as well as of the Brückner theory G-matrix calculations. We shall discuss the results and compare them with those obtained by other nonlocal potentials (Tabakin, Mongan, Hammann) and by the local Reid soft-core potential. (auth)

14358 EFFECT OF DEUTERON BREAKUP ON ELASTIC DEUTERON–NUCLEUS SCATTERING. Rawitscher, G. H. (Center for Theoretical Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139 and Department of Physics, University of Surrey, Guildford, Surrey, England). Phys. Rev. C 9: No. 6, 2210-2229 (June 1974).

The properties of the transition matrix elements $V_{sk}(R)$ of the breakup potential V_N taken between states $\phi_s(\vec{r})$ and $\phi_k(\vec{r})$ are examined. Here $\phi_s(\vec{r})$ are eigenstates of the neutron–proton relative-motion Hamiltonian, and the eigenvalues of the energy, ϵ_s are positive (continuum states) or negative (bound deuteron); $V_N(\vec{r}, \vec{R})$ is the sum of the phenomenological proton nucleus $V_{p-A}(\vec{R} - 1/2\vec{r})$ and neutron nucleus $V_{n-A}(\vec{R} + 1/2\vec{r})$ optical potentials evaluated for nucleon energies equal to half the incident deuteron energy. The bound-to-continuum transition matrix element for relative neutron–proton angular momenta $l = 2$ are found to be comparable in magnitude to the ones for $l = 0$ for values of ϵ_s larger than about 3 MeV, and both decrease only slowly with ϵ_s, suggesting that a large breakup spectrum is involved in deuteron–nucleus collisions. The effect of the various breakup transitions on the elastic phase shifts is estimated by numerically solving a set of coupled equations. These equations couple the functions $\chi_s(\vec{R})$ which are the coefficients of the expansion of the neutron–proton–nucleus wave function in a set of the $\phi_s(\vec{r})$'s. The equations are rendered manageable by performing a (rather crude) discretization in the neutron–proton relative-momentum variable k_s. Numerical results for 21.6-MeV deuterons incident on Ni and Ca which include only the first momentum bin ($\epsilon_s \leq 10$ MeV) and $l = 0$ and 2 show that the effects on the elastic phase shifts are similar in several respects to those found by Johnson and Soper. (auth)

14359 RECOIL CORRECTIONS IN HEAVY-ION-INDUCED TRANSFER. Baltz, A.J.; Kahana, S. (Brookhaven National Laboratory, Upton, New York 11973). Phys. Rev. C 9: No. 6, 2243-2251 (June 1974).

A perturbative approach for rapid calculation of recoil corrections to heavy-ion distorted-wave Born approximation has been developed. Without making either the local momentum approximation or the Hankel function approximation, we expand the final scattering wave function about $\vec{r}_f = \alpha\vec{r}_i$. We have modified the existing no-recoil code RDRC to include exactly the first-order term, allowing one to correct for both longitudinal and transverse recoil effects. Sample calculations have been performed, including an analytically solvable test case, plus the reactions ^{94}Mo(^{13}C, ^{12}C)^{95}Mo and ^{48}Ca(^{14}N, ^{13}C)^{49}Sc for which data have

been taken and analyzed previously with RDRC. The relative α independence of the results argues strongly for convergence. (auth)

14360 COMBINATORIAL CALCULATIONS OF NUCLEAR LEVEL DENSITIES, SPIN PROJECTIONS, AND NUCLEAR DEFORMATION. Hillman, M. (Brookhaven National Laboratory, Upton, New York 11973). Phys. Rev. C 9: No. 6, 2289-2296 (June 1974).

Calculations similar to those previously used for a spherical nucleus were performed at various deformations ranging in some cases from $\delta=-0.5$ to $\delta=1.0$. The states for each spin projection (K) were ordered according to energy to avoid crossing of states with same spin projection and parity. The corresponding energies of the ordered sets for each deformation were considered as the energy versus deformation for particular states. Energies at intermediate deformations were obtained using a cubic interpolation. Energy minima and their associated deformations were determined for each state. States often have more than one energy minimum indicating the presence of shape isomers as illustrated in the cases of ^{166}Ho and ^{240}Pu. In the former, a prolate and an oblate minimum exist which persist at higher energies. In the latter, a second prolate minimum is observed where the fission isomer is expected. Differences in energy gaps are discernible in the various minima. A plot of the deformations corresponding to the energy minima of the lowest energy states for each spin projection (the yrast levels) versus the spin projection reveals that the model nucleus becomes more oblate as the spin projection increases. The change in oblateness contains discontinuities. A plot of these yrast deformations vs the yrast energies for various nuclides indicates an apparent independence of the kind or size of the nuclide. The "best" G's (pairing parameters) for some nuclides were determined by fitting the level densities to the experimental values at the neutron binding energies. The results for deformed nuclei are compared with the earlier results obtained for spherical nuclei. (auth)

14361 REAL-WELL DEPTH OF THE OPTICAL POTENTIAL. Agrawal, D.C.; Sood, P.C. (Nuclear Physics Section, Physics Department, Banaras Hindu University, Varanasi 221005, India). Phys. Rev. C 9: No. 6, 2454-2458 (June 1974).

An examination of the results of the optical-model analyses of the experimental data obtained by the scattering of protons with energies varying from 9.8 to 61.4 MeV from target nuclei in the mass range from 40 to 208 is carried out to look for the linear dependence of the real potential-well depth on the target mass number A which had been unexpectedly revealed in the analysis of 11-MeV proton scattering from nuclei having a mass between 45 and 70. It is found that such an A dependence cannot be extrapolated as such to heavier nuclei at any energy. An assumed linear variation over the whole mass region yields a coefficient which is an order of magnitude smaller than that deduced for the restricted mass region and which has a much wider scatter from linear dependence. Such a behavior could possibly be simulated in part by the isospin-dependent potential, the Coulomb correction term in the potential, and the closed-shell effects. (auth)

14362 L-SHELL INTERNAL IONIZATION ACCOMPANYING L CAPTURE. Mukoyama, T.; Kitahara, T.; Shimizu, S. (Institute for Chemical Research and Radioisotope Research Center, Kyoto University, Kyoto, Japan). Phys. Rev. C 9: No. 6, 2307-2311 (June 1974).

The L-shell internal ionization accompanying L capture has been considered. Numerical calculations of the internal-ionization probabilities per L capture and the energy spectra of electrons ejected during this process are presented for low-energy transitions in high-Z elements. Screened relativistic hydrogenic wave functions are used. The effect of the presence of a hole resulting from electron capture is included in the screening constant for the daughter atom. It is shown that the ionization probability per L capture depends upon B_i/E_0, where E_0 is the transition energy of the ordinary electron capture and B_i is the L_i-shell binding energy of the daughter atom ($i = 1,2,3$). The calculated results also predict that observation of this process is possible when the K-shell internal-ionization process during K capture is forbidden energetically. Possible experiments to detect this phenomenon are briefly discussed. (auth)

14363 L-SHELL CONTRIBUTIONS TO INTERNAL IONIZATION ACCOMPANYING ELECTRON CAPTURE. Mukoyama, T.; Shimizu, S. (Institute for Chemical Research and Radioisotope Research Center, Kyoto University, Kyoto, Japan). Phys. Rev. C 9: No. 6, 2300-2306 (June 1974).

The L-shell internal-ionization probability accompanying K capture, K-shell internal-ionization probability accompanying L capture, and the ejected-electron spectrum during these processes have been calculated using screened relativistic hydrogenic wave functions. The screening constant for the daughter atom is determined taking into account the presence of a vacancy resulting from electron capture. The results show that L-shell contributions are important for the low-energy region of the electron spectrum and for high-Z elements. It is also concluded that the presence of a vacancy in the inner shell of the daughter atom plays an important role. (auth)

14364 VANISHING CURRENT IN THE GROUND STATE OF PION-CONDENSED SYSTEMS. Sawyer, R.F.; Soni, V. (Department of Physics, University of California, Santa Barbara, California 93106). Phys. Rev. D 9: No. 8, 2480-2481 (15 Apr 1974).

Baym's theorem on the vanishing of the current in the ground state is shown, in the case of a running-wave π^- condensation, to be realized only when a π^+ wave (of smaller amplitude) is added, moving in the opposite direction to the π^- wave. Here the division into π^+ and π^- quanta is defined with respect to the standard free-field quantization of the pion field. This ground state was previously noted by Sawyer and Yao. Baym's criticisms of the methods used in previous work are shown to be unjustified. (auth)

14365 SOLVABLE DISTORTED THREE-CLUSTER WAVE FUNCTION APPLICABLE TO HEAVY ION REACTIONS. Osman, A. (Cairo Univ.). Particles Nucl.; 7: No. 1-2, 29-40(1974).

A set of distorted wave functions is constructed for a three cluster system. Considering heavy ion reactions with nucleon transfers, projection operators are introduced to avoid the non-orthogonality between the different channels. The obtained set of distorted cluster wave functions includes the distortion effects. The motion of the heavy cores is also taken into account. (auth)

14366 DOORWAY STATES AND PRE-EQUILIBRIUM REACTIONS. Feshbach, H. (Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). Rev. Mod. Phys. 46: No. 1, 1-5 (Jan 1974).

A quantum foundation is developed for the methods employed in the calculation of the pre-equilibrium component of the energy spectrum of nuclear reaction products. It involves the application of the statistical theory of nuclear reactions to chained doorway states. (auth)

14367 REGGE-POLE DESCRIPTION OF NUCLEUS-NUCLEUS SCATTERING. Abul-Magd, A. Y. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Z. Phys.; 266: No. 5, 391-395(Feb 1974).

The properties of the Regge poles of the S-matrix for scattering of strongly absorbed nuclear particles are considered. Simple formulas are obtained for describing the Regge trajectories in terms of the nuclear radius, the quasi stationary levels in the combined nuclear-Coulomb-potential and the widths of these levels. The predictions of these formulas are compared with the Regge trajectories obtained previously, for a Woods-Saxon potential, and with those required to fit ^{16}O-^{12}C backward scattering. (GE)

14368 TIME EVOLUTION OF GENERATOR COORDINATES. Reinhard, P. G.; Rowley, N.; Brink, D. M. (Oxford Univ.). Z. Phys.; 266: No. 2, 149-155(Jan 1974).

The parameters of the generator coordinate theory are allowed to be complex and time dependent. Their time dependences are found by a variational principle which automatically yields a normalization and energy which are independent of time. The parameters satisfy equations of motion analogous to Hamilton's equations of classical mechanics. This analogy is exact if the overlap function is Gaussian. Combinations of the parameters may be found which form conjugate pairs, a procedure which may be useful in defining appropriate variables for the construction of a collective Hamiltonian. Conditions are derived under which the parameters may be chosen to be real. It is shown that for a cranking model wave function the collective parameters may be made real if the collective Hamiltonian is harmonic. Reality of the parameters with a general Hamiltonian, however, is shown to require a restricted set of generator coordinate spaces which embrace the Gaussian overlap approximation. (auth)

14369 LEAST SQUARES ADJUSTMENT OF THE COUPLING CONSTANTS IN NUCLEAR BETA-DECAY. Kropf, A.; Paul, H. (Hochschule fuer Sozial- und Wirtschaftswissenschaften, Linz, Austria). Z. Phys.; 267: No. 2, 129-133(Mar 1974).

Assuming the V-A theory, fully polarized neutrinos, and lepton conservation, best values of the vector and axial vector coupling constants are deduced from all available data on neutron decay and from the ft-values of ^{14}O, ^{26m}Al and ^{34}Cl. Special consideration is given to the treatment of errors to radiative corrections. $G_A/G_V = 1.250 \pm 0.009$ with a phase angle phi $= (181.1 \pm 1.3)^0$ is found. From the weighted mean ft-value, including charge dependent and "outer" radiative corrections, an effective coupling constant $G_V = (1.413 \pm 0.002) \times 10^{-49}$ erg cm^3 is found. The error is mainly due to the uncertainty of charge dependent corrections. (GE)

14370 EXCITATION FUNCTIONS IN CLOSED FORM FOR COMPOUND-NUCLEUS REACTION MECHANISM. Gottschalk, P. A. (Univ., Marburg, Ger.). Z. Phys.; 266: No. 5, 347-356 (Feb 1974). (In German).

Theoretical excitation functions in closed form for compound-nucleus reaction mechanism followed by nuclear evaporation are

presented. Competition of neutron emission and charged-particle evaporation at the various stages of the evaporation chain is taken into account. The formula is derived in the framework of the nuclear evaporation model of Weisskopf using conventional Fermi gas level densities and continuum-theory reaction cross sections approximated by an empirical formula by Dostrovsky. Experimental and theoretical excitation functions are compared. The agreement of the experimental results with those calculated using the closed formula, while not entirely satisfactory, is as good as with those computed numerically with considerable effort by other authors. (GE)

14371 CLASSICAL HAMILTONIANS IN THE GENERATOR COORDINATE THEORY. Reinhard, P. G. (Oxford Univ.). Z. Phys.; 266: No. 5, 377-383(Feb 1974).

In the generator coordinate theory one can introduce a classical Hamiltonian in two ways: either by considering an explicit time evolution of the generator coordinate or by applying a kind of WKB approach. The two different definitions are compared for a Gaussian overlap space and for a further example of redundant double projection spaces. The WKB choice seems to be preferable due to its close connection with the momentum expansion of the Griffin-Hill-Wheeler equation and because it is free from the zero-point energies from kinetic terms. (GE)

14372 THEORY OF STRIPPING REACTIONS INTO THE CONTINUUM. Baur, G. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Z. Phys.; 267: No. 2, 103-109(Mar 1974).

A formulation of stripping reactions into the continuum is given taking the (d,p)-reaction as a specific example. The DWBA and the assumption that contributions from the nuclear interior are negligible are used. Under these assumptions it is shown that the cross section can be split into a "distortion matrix element" and a term depending on the neutron target interaction only through the phase shifts of the corresponding elastic neutron scattering. The interference with the "pure break-up" process is discussed. The connection between stripping to bound and unbound states in the limit of zero binding energy is established. A comparison with recent experimental results is given, where the "distortion matrix elements" are calculated, for the sake of simplicity, in the "Butler approximation". (GE)

14373 NEW APPLICATION OF THE GENERATOR COORDINATE METHOD. Faessler, A. (Kernforschungsanlage Juelich, Ger.); Plastino, A. Z. Phys.; 266: No. 5, 405-408 (Feb 1974).

A particle-number projection study with the generator coordinate method is performed in relation to the microscopic description of odd-even nuclei. Odd-even mass differences are calculated and compared to experimental and BCS results. (GE)

PHYSICS (RADIATION AND SHIELDING)

Radiation Physics

Refer also to abstracts 12314, 12723, 12724, 12763, 12849, 12865, and 13260.

14374 (EUR-5122(Vol. 1)) FOURTH SYMPOSIUM ON MICRODOSIMETRY, VERBANIA PALLANZA, ITALY, 24–28 SEPTEMBER 1973. Booz, J.; Ebert, H. G.; Eickel, R.; Waker, A. (eds.). (Commission of the European Communities, Luxembourg). Mar 1974. 605p. (In French and English). (CONF-730952-P1). EUR B.Fr. 1.000.

Separate abstracts were prepared for 22 of the 28 papers presented. The remaining six papers previously appeared in NSA. For abstracts of these papers refer to CONF-730952 in a cumulative report number index. (CES)

14375 (EUR-5122(Vol. 1), pp 35-58) CHARACTERISTICS OF SECONDARY ELECTRON EMISSION AND SOME POTENTIAL APPLICATIONS TO MICRODOSIMETRY. Burlin, T. E. (Polytechnic of Central London). Mar 1974.

From fourth symposium on microdosimetry; Verbania, Italy (24 Sep 1973).

The theoretical and experimental bases of secondary electron emission are reviewed, and potential applications of the phenomenon to microdosimetry are indicated. The term secondary electron is here confined to electrons leaving a surface with energy between 0 and 50 eV, though this only constitutes part of the "slowing-down" spectrum. (CES)

14376 (EUR-5122(Vol. 1), pp 59-73) ROLE OF SECONDARY PARTICLES IN MICRODOSIMETRY. Baily, N. A.; Steigerwalt, J. E. (Univ. of California, San Diego, La Jolla). Mar 1974.

From fourth symposium on microdosimetry; Verbania, Italy (24 Sep 1973).

Experimentally determined frequency distributions of energy deposition by protons and those calculated from a theoretical method which makes use of experimental data are compared for two widely separated proton energies. The influence on such spectra by the loss of secondaries from the measuring volume is illustrated. A new method based on the multiwire proportional counter which can be used to examine the ability of various charged particles to produce secondaries and to study some characteristics of these secondaries is discussed. It is shown that while the measurements made with this instrument suffer from certain deficiencies from a pure physics point of view, they can be used to make certain corrections to experimentally determined distributions functions. Such corrections are required to calculate energy deposition functions in volumes having a range of sizes and shapes if a minimum of experimentally determined distributions corresponding to discrete pathlengths are to be used. (auth)

14377 (EUR-5122(Vol.1), pp 123-140) APPROACHES TO PHYSICAL TRACK STRUCTURE CALCULATIONS. Paretzke, H. G.; Leuthold, G.; Burger, G.; Jacobi, W. (Gesellschaft fuer Kernforschung mbH, Munich). Mar 1974.

From fourth symposium on microdosimetry; Verbania, Italy (24 Sep 1973).

Ion track structure calculations, which are fundamental for investigations on radiation effects of heavy charged particles, are generally based on a two step formalism: the emission of secondary electrons by direct projectile-target interactions, and the following energy dissipation of these electrons. Both steps may be handled in a continuous approximation or stochastically; hybrid models are also possible. For an assessment of the accuracy of track structure calculations and their sensitivity on certain assumptions and to get information not accessible otherwise (e.g. on the statistics of energy deposition around an ion track), hybrid type and Monte-Carlo calculations have been performed in addition to extensive csda-calculations. The basic characteristics and advantages of the different approaches and some results of calculations are briefly discussed. (auth)

14378 (EUR-5122(Vol.1), pp 141-168) COMPARISON OF TRACK STRUCTURE CALCULATIONS WITH EXPERIMENTAL RESULTS. Paretzke, H. G. (Gesellschaft fuer Kernforschung mbH, Munich). Mar 1974.

From fourth symposium on microdosimetry; Verbania, Italy (24 Sep 1973).

The details of track structure of heavy charged particles are known to be of fundamental importance for the understanding of radiation-biological and many other radiation effects. Since the physical processes of energy absorption, transport and localization during the penetration of these ions through solid or liquid target materials take place in very short times and in submicroscopic dimensions, many track structure quantities of interest presently are not and presumably will never be accessible to direct experiments. Therefore, one must try to calculate these quantities. Which of them will be of final importance with respect to a specific radiation effect, will have to be decided by correlation studies. To provide the basis for such studies, track structure calculations (csda-, mixed csda-Monte Carlo- and full Monte Carlo-models) for heavy ions have been carried out, some results of which will be presented. The applicability of electron ejection cross sections measured in gases and used in these calculations for the condensed phase is shown for ions heavier than protons, where almost no experiments or theories exist and other effects come into play, are discussed. Special emphasis will be given to comparisons of theoretical results with experimental data. The good agreement found in these comparisons indicate that it is possible to calculate from first principles many details of the track structure of heavy charged particles in condensed matter with reasonable accuracy, at least for low Z ions. (auth)

14379 (EUR-5122(Vol.1), pp 169-188) ENERGY DENSITY DEPOSITED BY A HEAVY ION AROUND ITS PATH. Fain, J.; Monnin, M.; Montret, M. (Univ. de Clermont Ferrand, France). Mar 1974.

From fourth symposium on microdosimetry; Verbania, Italy (24 Sep 1973).

A model of heavy ion track structure in space is presented. This model deals with more than 1 MeV/n ions travelling in water (or biological media). The model intends to describe the energy state of the medium within 10^{-13} s after the ion propagation. Energy directly deposited by the incident particle and energy deposited by secondary electrons are taken into account as well. Attention is paid to the different ways by which the energy is deposited (ionization, excitation, and molecular vibration). Results are compared with available experimental data (energy needed to form an ion pair particularly), the agreement is satisfactory. A comparison is made for track structure of ions with different energy and charge states, and also with the behavior of the low LET particles. (auth)

14380 ^{169}Yb-EQUILIBRIUM ABSORBED-DOSE CONSTANT. Kirchner, P. T.; Soong, A. L. (John Hopkins Medical Inst., Baltimore). Radiology; 112: No. 1, 209-210(Jul 1974).

The equilibrium absorbed-dose constants for internally deposited ^{169}Yb in patients were calculated and are presented in tabular form. (auth)

14381 ALGORITHM OF FINDING FUNDAMENTAL SOLUTIONS OF GAMMA TRANSPORT EQUATION. Shulaya, D. A. Soobshch. Akad. Nauk Gruz. SSR; 74: No. 1, 17-20(Apr 1974). (In Russian).

The algorithm of finding fundamental solutions of the gamma-ray transport equation in plane geometry for the case of anisotropic scattering and energy dependence is considered in application to a particular boundary problem. (auth)

14382 VOLUME DOSES DETERMINED BY COMPUTER FROM DOSE-DISTRIBUTION MEASUREMENTS. Bozoky, L. (National Oncological Inst., Budapest); Varjas, G.; Erdelyi, K.; Kaczmarsky, A.; Nikl, I. Acta Biochim. Biophys. (Budapest); 8: No. 2, 105-110(1973).

The work covered the experimental examination of the variation of volume doses with electromagnetic radiations of various energies in case of identical skin doses and nearly parallel beams corresponding to the cosmic space. Experiments were performed with a large-sized dog phantom made of a compound termed Mix-D and cut into slices by planes perpendicular to the direction of radiation. In the planes of section exposures were taken on films in order to determine dose distribution and small size condenser ionization chambers were irradiated for direct calibration of the films. The densitometry of the films at the corner points of a square-centimeter network gave several thousands of measurements results for each sort of radiation, from which the volume doses falling upon the individual sections were determined with a computer by the reiterated application of the Mayneord formula (Jaeger, 1959). The measurements were performed at 250 cm focus-to-skin distance with ^{60}Co gamma radiation and with X-rays of three different qualities: 200 kV and 0.5 mm Cu filter, 100 kV and 0.35 mm Cu filter, 70 kV and 1 mm Al filter. (auth)

14383 ENERGY DEPENDENCE OF ELECTRON ATTENUATION LENGTH IN THIN ALKALI HALIDE LAYERS. Kisiel, W.;

Lewowski, T. (Univ., Wroclaw). Acta Phys. Pol.; A45: No. 5, 749-754(May 1974).

The mean electron attenuation length L in thin layers of some alkali halides was determined by measuring the photoelectron absorption coefficient. The value of L increases linearly with increasing uv photon energy for most salts except those exhibiting optical absorption in the spectrum region considered. In that case the electron affinity was estimated by measuring the photoelectric threshold for the salt. No space-charge effects have been observed. (auth)

14384 COLLECTIVE DOSE. Radiol. Prot. Bull.; No. 7, 3, 10(Apr 1974).

Brief editorial criticism is made of the use of collective dose as a source of information on dose distribution as a whole. It is pointed out that collective dose as defined by the ICRU is simply the area of the dose distribution curve. It is suggested that the arithmetic mean dose should also be taken into consideration, because if the dose distribution covers a wide range of individual doses, both biological and social non-linearity would increasingly invalidate the simple use of collective dose as the spread of doses increases. Adding collective doses from several distributions with very different mean values would produce a dosimetrically valid result, but would be unlikely to produce meaningful interpretation in terms of consequences. (UK)

14385 IONIZATION LOSS FOR HIGH-ENERGY ELECTRONS IN THIN TARGETS. O'Brien, J.T.; Crannell, H.; Kline, F.J. (Department of Physics, The Catholic University of America, Washington, D.C. 20017); Penner, S. Phys. Rev. C 9: No. 4, 1418-1429 (Apr 1974).

The most-probable ionization loss has been measured for relativistic electrons passing through thin absorbers of carbon, aluminum, and copper. Incident energies of 50 and 100 MeV were used. Target thicknesses ranged from 48 to 614 mg/cm^2 and encompass the range of thicknesses most frequently used in electron scattering experiments at these energies. The measured values of the most-probable ionization losses are in good agreement with the theoretical predictions of Sternheimer. The techniques for using values of the ionization loss to determine the target thickness in electron scattering experiments are presented. (auth)

14386 TOTAL INELASTIC ENERGY LOSS BY HEAVY IONS STOPPED IN A GAS. Miller, M.S.; Boring, J.W. (Department of Engineering Science and Systems, University of Virginia, Charlottesville, Virginia 22901). Phys. Rev. A 9: No. 6, 2421-2433 (June 1974).

Calculations are made of the total energy lost to inelastic channels when a fast ion or atom is stopped in a gas. Contributions to this energy loss by sufficiently energetic recoil atoms are included using a scheme of successive approximations which reveals the relative importance of successive generations of recoils. The electronic energy losses resulting from a single collision are computed according to the theories of Lindhard and of Firsov which are modified by the presence of a threshold function. It is shown that such a threshold is essential to calculations employing physically reasonable interaction potentials. Energy losses associated with the nuclear motion are treated as classical elastic scattering, and the sensitivity of the calculations to the assumed potential is demonstrated. The relative accuracy of approximations to the deflection function computed for several potentials is investigated. (auth)

14387 UNIVERSAL RANGE-VELOCITY AND STOPPING-POWER EQUATIONS FOR FISSION FRAGMENTS AND PARTIALLY STRIPPED HEAVY IONS IN SOLID MEDIA. Mukherji, S.; Srivastava, B.K. (Department of Chemistry, Indian Institute of Technology, Kanpur-16 U.P., India). Phys. Rev. B 9: No. 9, 3708-3719 (1 May 1974).

The applicability of Bohr's stopping-power formula for range and stopping-power calculations has been investigated by a detailed analysis of the available range data for fission products in various solid media (Be, C, Al, Si, Cu, Zr, W, Au, and U). In the case of heavy media ($Z \geq 45.5$), the result of the analysis is in agreement with the Thomas-Fermi statistical approach for obtaining the effective quantum number for the outer orbital electrons and also with Bohr's original estimate of the effective charge of a fast-moving heavy ion. In the case of light media, an empirical function $n(U_s) = 0.28Z^{2/3}U_s/V_0$ is found necessary in place of $n(U_s) = Z^{1/2}U_s/V_0$, where $n(U_s)$ is the number of orbital electrons in a medium of atomic number Z whose velocities are less than a given velocity U_s and $V_0 = e^2/\hbar$. The incorporation of these findings into Bohr's stopping-power formula leads to universal stopping-power and range-velocity equations valid for partially stripped ions ($Z > 30$) in different solid media, including compound media of known molecular formula. Available experimental data on stopping powers and ranges of heavy ions in various solid media and also the equilibrium charges of very light ions in gaseous media are in excellent agreement with the corresponding calculated values. (auth)

14388 MODIFICATION OF A LOCAL ESTIMATE OF PARTICLE FLUX BY A MONTE CARLO METHOD. Mikhalov, G. A. Zh. Vychisl. Mat. i Mat. Fiz.; 13: No. 3, 574-582(1973). (In Russian).

The proposed modification is based on the following generalization of "the method of maximum cross-section" for modeling the mean free path of a particle. Let the coefficient $\sigma(r)$ of the flux attenuation satisfy the inequality $\sigma(r) < \sigma_m(r)$. The particle flux does not change if $\sigma(r)$ is replaced by $\sigma_m(r)$ while considering the value $\sigma_m(r) - \sigma(r)$ as a coefficient of fictitious scattering without a change in path. The well known "local estimate" in this case remains undisplaced if the corresponding value calculated with collisions at the point r is multiplied by the ratio $\sigma(r)/\sigma_m(r)$. The coefficient $\sigma_m(r)$ can be selected in such a fashion that the order of probability convergence averaged over N trajectories of the estimate would be equal to $(\ln N/N)^{1/2}$ instead of $N^{-1/3}$ in the case of the ordinary estimate. This modification assures fulfillment of the central limiting theorem. The conclusions are confirmed by detailed calculations. 2 tables. 11 references. (SJR)

14389 MONTE CARLO APPROACH TO THE SPATIAL DEPOSITION OF ENERGY BY ELECTRONS IN MOLECULAR HYDROGEN. Heaps, M.G.; Green, A.E.S. (Department fo Physics and Astronomy, University of Florida, Gainsville, Florida 32611). J. Appl. Phys. 45: No. 7, 3183-3188 (July 1974).

The Monte Carlo (MC) and continuous slowdown approximation (CSDA) approaches to the spatial deposition of energy by elecirons are compared using the same detailed atomic cross section (DACS). It is found that the CSDA method overestimates the amount of energy that is deposited near the end of the path for electrons above a few hundred electron volts. The MC results are in approximate agreement with experimental data in such a way as to be relatively independent of the actual gas used. Our MC results are extended to obtain the three-dimensional deposition of energy by sub-keV electrons in molecular hydrogen. (auth)

14390 CHARACTERIZATION OF THE DOSE FROM A PULSED ELECTRON BEAM USING HOLOGRAPHIC INTERFEROMETRY. Mix, L.P. (Electron Beam Physics Division 5242, Sandia Laboratories, Albuquerque, New Mexico 87115); Perry, F.C. J. Appl. Phys. 45: No. 7, 2961-2963 (July 1974).

Energy deposition of a pulsed electron beam has been investigated using double-pulse holographic interferometry. The technique has been shown to provide depth-dose data over the illuminated area for a thermoelastic absorber. Possibilities of employing the method at higher doses are discussed. (auth)

14391 HEAVY COSMIC-RAY EXPOSURE OF APOLLO 17 ASTRONAUTS. Benton, E. V. (Univ. of San Francisco); Henke, R. P.; Bailey, J. V. Health Phys.; 27: No. 1, 79-85(Jul 1974).

The results of the HZE particle crew dosimetry on Apollo 17 are presented. The measurements are derived from the analysis of 11 passive detectors distributed among the astronauts, the film bag, and a detector located in the Biocore experiment. The individual astronaut's exposure was measured by means of Lexan plastic foils located on the chest, thigh and ankle of each crew member. A mission average planar fluence of 13.4 ± 0.5 particles per cm^2 with $LET_{350} > 0.15$ MeV/μ in Lexan ($LET_{350} > 130$ keV/μ in tissue) was recorded. This represents about a $24 \pm 12\%$ increase over the Apollo 16 fluence with the comparison being made between detectors located in similar location. As on earlier missions, significant differences in the recorded HZE exposure were found between the different detectors' packets. The Command Module pilot's exposure was found to be measurably lower than those of the Commander and the Lunar Module pilot who received comparable exposures. The exposure at the ankle appears to be consistently higher than that found at the chest or the thigh positions. As before, the highest exposure was recorded by the detectors located in the film bag, while the detectors located in the A6 locker (Biocore experiment) recorded an exposure comparable to the average exposure of the Command Module pilot. These measurements, carried out on the last Apollo mission, confirm the data trend which was steadily emerging in the earlier missions: the HZE particle exposure is sensitive to the shielding environment of the astronauts, including the self-shielding of the astronaut's bodies, and with the progress of the Apollo program, there has been a gradual, steady increase of the crew exposure. (auth)

14392 IONIZED-BEAM ENERGY LOSS TO ELECTRON GAS. Shah, S.; Srivastava, M. P.; Kothari, L. S. (Univ. of Delhi). Phys. Status Solidi (b); 62: No. 2, 481-489(1 Apr 1974).

The stopping power and other transport coefficients have been calculated for ionized beams channeling through a crystal using a statistical method developed by Chandrasekhar. Only the interaction of beam particles with conduction electrons, treated as a free gas, is considered. Unlike earlier investigations, also the

effect on the test particles of encounters with faster field particles is considered. Two types of potentials have been used, a Debye and a Coulomb one. Both potentials give nearly the same results. It is found that the values of energy loss and transport coefficients increase with increasing energy of the incident beam. The stopping power is nearly the same as that obtained by earlier workers. (auth)

14393 WALL CONDITIONS OF THE SPECIFIC DENSITY OF A RADIATION FIELD. Ferrari, C. Atti Accad. Sci. Torino. I. Cl. Sci. Fis., Mat. Natur.; 107: No. 3, 271-286(1973). (In Italian).

A radiation field incident to a surface limiting a metallic body is considered and the equation defining the specific intensity of the radiation emitted from the surface in a given direction is written. This is done in two parts: the first corresponds to the incident radiation and the second to that emitted from the surface. The first part is given by an integral relation in which the specific intensity of the incident radiation appears multiplied by the bi-angular spectral reflectivity coefficient $r''_{s\nu}$. This coefficient is connected in turn to the spectral reflectivity coefficient $r'_{s\nu}$ of the surface from an integral relation which gives $r'_{s\nu}$ when $r''_{s\nu}$ is known. Since the electromagnetic theory and experiments give $r'_{s\nu}$, the relation itself is inverted giving a hypothesis on the form of $r''_{s\nu}$ which satisfies a known reciprocity principle used by Chandrasekhar. The second part corresponds to the radiation emitted from the surface in the radiation frequency interval capable of producing the Einstein photoelectric phenomenon. It was shown how this is reduced to the Kirchoff law in the case where the system is in thermodynamic equilibrium. (tr-auth)

14394 CONSIDERATION OF FACTORS FOR THE DETERMINATION OF THE ABSORBED DOSE FROM EXPOSURE MEASUREMENTS IN THE BEAM OF ^{60}Co TELETHERAPY UNITS. Bozoky, L. (National Oncological Inst., Budapest); Nagl, J.; Haider, J. G. Acta Phys. Acad. Sci. Hung.; 35: No. 1-4, 105-112(1974).

Most frequently the absorbed dose is determined by calculations from exposure measurements with ionization chambers. In order to check the calculations, the ratio rad/Roentgen depending on the depth in the material was examined by direct measurement of the absorbed dose with a graphite calorimeter and exposure with an ionization chamber calibrated for ^{60}Co radiation. These measurements were performed in the beam of two special ^{60}Co teletherapy units. The difference of 9 per cent in the ratio mentioned above can be explained by the details of construction and the amount of scattering material in the vicinity of the radiation source, which changes the energy spectrum of the radiation beam to different extents. Therefore, for reasonable accuracy, the factor f_{exp} should be determined by direct measurement for each type of ^{60}Co teletherapy unit. (auth)

14395 FUNDAMENTALS OF X AND GAMMA METROLOGY. Brosed Serreta, A.; Granados Gonzalez, C. E. Energ. Nucl. (Madrid); 17: No. 83, 173-194(1973). (In Spanish).

The general aspects of the metrology of x and γ rays are reviewed beginning with the basic concepts and terminology. The most authoritative definitions of radiological values most commonly used in metrological laboratories are given. Some concepts often causing confusion in non-specialists are explained. The mutual relations between the different radiological values and the validity conditions for the equivalence equations between them are summarized. (tr-auth)

14396 ESTIMATION OF QUALITY FACTOR AND RBE FOR DEGRADED FISSION NEUTRON SPECTRA. Murthy, M. S. S.; Bhatt, R. C.; Shinde, S. S. (Bhabha Atomic Research Centre, Bombay). Health Phys.; 27: No. 1, 9-17(Jul 1974).

A number of fission neutron spectra which were obtained under various conditions of neutron moderation and shielding have been analysed to yield distribution of dose in LET. From this analysis parameters such as the capture gamma contribution and the quality factor (QF) for chronic exposures and Relative Biological Effectiveness (RBE) for acute exposures have been calculated at various depths in an athropomorphic phantom. These calculations show that: (i) the LET distribution of dose is dependent upon the shape of the incident neutron spectrum; (ii) the contribution from intermediate energy neutrons to the total neutron dose increases with increasing neutron moderation and becomes a significant part of the total neutron dose from heavily moderated fission spectrum; (iii) the contribution from the capture γ rays increases with the softening of the neutron spectrum and hence with the depth in the phantom; (iv) the QF and RBE as obtained for the surface element of the phantom are not strongly dependent upon the degree of moderation undergone by the incident fission spectrum; (v) the variation of QF with depth in the phantom is significant when one goes from a pure fission spectrum to a highly moderated incident fission spectrum. However the corresponding variation in RBE is not significant. Based on this analysis a quality factor value of 9 and an RBE of 2 for fission neutrons have been suggested for personnel doses received under chronic and acute exposure conditions respectively without any reference to the exact shape of the neutron spectrum. (auth)

14397 GAMMA-RAY ATTENUATION COEFFICIENTS FOR HIGHER GREEN PLANTS. Tsoulfanidis, N. (Missouri Univ., Rolla). Health Phys.; 27: No. 1, 145-147(Jul 1974).

When γ-ray dose absorbed by higher green plants is calculated, it is necessary to know the γ-ray total mass attenuation coefficient and the absorption mass attenuation coefficient for the material of which the plant is made. Calculations of these coefficients for γ-ray energies between 10 keV and 10 MeV have been carried out and are reported. The results presented indicate that when water content changes from 50 to 90% but dry matter composition is kept constant, both total and absorption mass attenuation coefficients change by less than 3% for all energies between 10 keV and 10 MeV. This leads to the conclusion that dry matter rather than water content determines the values of the attenuation coefficients. (UK)

Radiation Protection Standards

Refer also to abstract 14699.

14398 LIMITATIONS OF THE USE OF THE GEOMETRIC MEAN TO OBTAIN DEPTH INDEPENDENCE IN SCANNING AND WHOLE BODY COUNTING. Tothill, P. (Univ. of Edinburgh). Phys. Med. Biol.; 19: No. 3, 382-385(May 1974).

Brief criticism is made of the use of the geometric mean of counts from both sides to obtain depth independence in scanning and whole body counting. It is pointed out that the mathematical derivation is confined to a point source and the experimental justification to individual point and volume sources. The presence of multiple sources is considered and studies of a volume source discussed in relation to a cylindrical source, dia. 6 cm, volume 220 ml, filled in turn with ^{131}I, ^{99m}Tc and ^{125}I. Curves of count rate variation with depth of source (27, 140, and 364 keV) are presented for (a) a single detector, (b) the arithmetic mean of count rates from two opposed detectors, (c) the geometric mean of count rates from two opposed detectors. (UK)

14399 ENERGY FLUENCE PER ROENTGEN. An Apparent Paradox and Its Resolution. McDavid, W. D.; Waggener, R. G. (Texas Univ., San Antonio). Phys. Med. Biol.; 19: No. 3, 389-391(May 1974).

Brief criticism is made of the statement that the energy absorbed by a gram of air at a point irradiated by a photon beam with energy fluence Ψ falling uniformly on 1 cm^2 is found by taking the product of Ψ and the mass energy coefficient, (Johns, H. E. and Cunningham, J. R., Physics of Radiology, 1971.). A modified expression is derived for the case when a gram of air is actually present, and it is shown that the original definition would lead to an incorrect deduction of absorbed energy by a factor of ~5 for a beam of 0.01 MeV. (UK)

14400 ARGUMENT AGAINST THE USE OF THE SPECIAL CURIE FOR NATURAL URANIUM AND NATURAL THORIUM. Hursh, J. B. (Rochester Univ., NY). Health Phys.; 27: No. 1, 147-152(Jul 1974).

The history of the occupational air and water limits for natural uranium is traced and strong arguments for abolishing the "special" curie for natural uranium are given. Reasons for abandoning the "special" curie for natural uranium as presented apply in general to the "special" curie for thorium and reinforce the case for discontinuing use of this confusing unit. (UK)

14401 SPECIFICATION OF UNITS FOR NATURAL URANIUM AND NATURAL THORIUM. Ney, W. R. (National Council on Radiation Protection and Measurements, Washington, DC). Health Phys.; 27: No. 1, 140(Jul 1974).

Confusion has arisen due to the use of a "special" curie applied specifically to natural uranium and natural thorium and its use may be regarded as compromising the integrity of the curie as a unit. The NCRP now recommends the discontinuation of the use of the "special" curie. Mass units should be used to define quantities of natural uranium as they appear in the specification of MPC and MPBB values. Inasmuch as the isotopic composition of natural thorium is not constant it is recommended that a limiting concentration used for natural thorium, as an entity, be discontinued, and that the established MPBB and MPC values for each of the individual thorium isotopes be utilized instead. (UK)

Radiation Source Calibration and Standardization

14402 REPORT TO THE INTERNATIONAL EXECUTIVE COMMITTEE OF THE THIRTEENTH INTERNATIONAL CONGRESS OF RADIOLOGY FROM THE INTERNATIONAL COMMISSION ON RADIATION UNITS AND MEASUREMENTS (ICRU). Ney, W. R. (International Commission on Radiation Units and Measurements, Washington, DC). Radiology; 112: No. 1, 225-228(Jul 1974).

The activities of the International Commission on Radiation Units and Measurements (ICRU) since 1969 are reviewed. Included are a discussion of its published reports, relationships with other organizations, finances, membership, and the outlook for the future. A document requesting opinions and arguments for and against replacing special radiation units with the International System of Units (SI) was prepared. (auth)

14403 COMITE CONSULTATIF POUR LES ETALONS DE MESURE DES RAYONNEMENTS IONISANTS. Section IV. Etalons d'Energie Alpha. (Consulting Committee for Measurement Standards of Ionizing Radiations. Section IV. Alpha Energy Standards). Sevres, France; Bureau International des Poids et Mesures (1972). 28p.

The Committee proceedings are presented. The studies undertaken by the International Bureau of Weights and Measures since 1968 and those planned for the near future are summarized. The compilation of recommended energy and intensity values for α particles is announced. The radionuclides to be studied for α energies and intensities are reported. (JSR)

14404 COMITE CONSULTATIF POUR LES ETALONS DE MESURE DES RAYONNEMENTS IONISANTS. Section III. Mesures Neutroniques. (Consulting Committee for Measurement Standards of Ionizing Radiations. Section III. Neutron Measurements). Sevres, France; Bureau International des Poids et Mesures (1972). 27p.

The Committee proceedings are presented. The present status in various national laboratories on the calibration of neutron sources is reported. The use of thermal neutron flux standards is summarized. The organization of a proposed international comparison of fast neutron fluxes is reported in detail. (JSR)

Shielding Calculations and Experiments

Refer also to abstracts 14545, 14546, and 14615.

14405 CALCULATION OF THE NEUTRON ENERGY SPECTRUM IN THE VICINITY OF IRON SHIELDS. Doerschel, B. (Technische Univ., Dresden). Kernenergie; 17: No. 3, 80-87 (Mar 1974). (In German).

The energy spectra of neutrons in front of and past iron shields of various thicknesses have been calculated by means of the Monte Carlo method. The calculational procedure is described for 14 MeV neutrons, fission neutrons, and VVR-S reactor neutrons. The results show that sometimes the spectra of transmitted and reflected neutrons essentially deviate from primary spectra. The spectra are discussed as a function of the shape of primary spectra and of the shield thickness. Information about changes in neutron intensity during transmission and reflection may be derived. (auth)

PHYSICS (THEORETICAL)

General

Refer also to abstracts 13918, 14062, 14067, 14078, 14497, and 14734.

14406 TRANSITIONS TO THE GROUND STATE IN SYNCHROTRON RADIATION. White, D. (Department of Physics, Illinois Institute of Technology, Chicago, Illinois 60616). Phys. Rev. D 9: No. 4, 868-874 (15 Feb 1974).

This paper will deal with the high-energy tip of the synchrotron spectrum. Specifically, we consider exact relativistic wave functions of an electron in a transverse magnetic field as the basis for the calculation of the transition rate to the ground state. (auth)

14407 EXPERIMENTAL DISTINCTION BETWEEN THE QUANTUM AND CLASSICAL FIELD-THEORETIC PREDICTIONS FOR THE PHOTOELECTRIC EFFECT. Clauser, J.F. (Department of Physics and Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). Phys. Rev. D 9: No. 4, 853-860 (15 Feb 1974).

We have measured various coincidence rates between four photomultiplier tubes viewing cascade photons on opposite sides of dielectric beam splitters. This experimental configuration, we show, is sensitive to differences between the classical and quantum field-theoretic predictions for the photoelectric effect. The results, to a high degree of statistical accuracy, contradict the predictions by any classical or semiclassical theory in which the probability of photoemission is proportional to the classical intensity. (auth)

14408 RAPID NUMERICAL SOLUTION OF THE ONE-DIMENSIONAL SCHROEDINGER EQUATION. Wills, J. G. (Univ. of Surrey, Eng.). Can. J. Phys.; 52: No. 7, 664-665(1 Apr 1974).

It is shown that the "new" method of rapid solution of the one-dimensional Schrödinger equation proposed by Newman and Thorson is equivalent to the well known phase-amplitude method. (auth)

14409 COMMUTATIVITY OF VELOCITY OPERATORS IN A SYSTEM OF BOSE PARTICLES. Yamasaki, S.; Kebukawa, T.; Sunakawa, S. (Osaka Univ.). Progr. Theor. Phys. (Kyoto); 50: No. 5, 1490-1500(Nov 1973).

The commutator of the velocity operators which are appropriate for the collective description of an interacting Bose system is found to be zero. On the basis of this result, it will be shown that the collective description of many-boson system is always possible without a subsidiary condition $\kappa \times V\kappa | \geq 0$. (auth)

14410 NEW INTEGRAL EQUATIONS FOR THE TRANSITION OPERATORS OF MANY-BODY SYSTEMS. Tobocman, W. (Physics Department, Case Western Reserve University, Cleveland, Ohio 44106). Phys. Rev. C 9: No. 6, 2466-2468 (June 1974).

A new set of coupled integral equations for the transition operators of a nonrelativistic quantum mechanical n-body system is presented. These equations are a generalization to the many-body system of a special case of a set suggested for the three-body problem by D. J. Kouri, M. Baer, and F. S. Levin. The Kouri-Baer-Levin formalism effectively couples together the Lippmann-Schwinger integral equations for the transition operators for all open channels thus simultaneously imposing all asymptotic boundary conditions. The effect of our specialization of these equations is to make the kernel of the integral equations connected so that the resulting equations appear to be a suitable basis for many-body calculations. (auth)

14411 APPROACH TO THE STUDY OF QUANTUM SYSTEMS. Hioe, F. T. (Univ. of Rochester, NY). J. Math. Phys. (N. Y.); 15: No. 4, 445-452(Apr 1974).

A perturbation method for quantum mechanical problems is presented in which the successive terms are obtained by algebraic recurrence relations without the use of any diagrams. Two examples, one an anharmonic oscillator with quartic self-interaction, and one a spin with quadratic self-interaction, are given to illustrate the use of this recurrence relation perturbation method. (auth)

14412 WAVEPACKETS FOR PARTICLES OF INDEFINITE MASS. Greenberger, D. M. (City Coll., New York). J. Math. Phys. (N. Y.); 15: No. 4, 406-412(Apr 1974).

Using a formalism that includes particles with indefinite and variable masses, one can create a much richer set of states than in conventional quantum mechanics. For example, in a gravitational field the equivalence principle implies that the motion of a particle is independent of the mass. Thus it is possible to create physical states with large Δm but very small Δv and Δx, so that the trajectory of a particle is well determined, while the $\Delta p \cdot \Delta x$ uncertainty relation is satisfied. Also a quantitative description of wave packets with arbitrary distributions in momentum and mass (or alternatively velocity and mass) is provided and a simple diffraction slit experiment is discussed as an example of their physical propagation. The Schroedinger equation is solved for a decaying particle at rest. It is also shown that Galilean invariance plays a natural and cohesive role within the variable mass formalism, unlike the case in conventional quantum mechanics where the existence of multiple mass states would violate Galilean invariance. (auth)

14413 SPACE-TIME CODE. IV. Finkelstein, D. (Belfer Graduate School of Science, Yeshiva University, New York, New York 10033). Phys. Rev. D 9: No. 8, 2219-2231 (15 Apr 1974).

A successor to quantum-mechanics is studied. It extends atomism from matter to physical process and unites certain quantum and relativity principles with stricter finiteness, operationality, and locality. A specific kinematics is given. In it particle processes are discrete networks of elementary quantum processes, monads, of a binary nonunitary kind with specific laws of combination. The general dynamics and several examples are given. The dynamical law is not differential but algebraic. The interpretation involves a small constant time τ. Familiar space-time and field-theory concepts, the Hilbert-space metric, and the Riemannian pseudometric emerge in the approximation $\tau \to 0$, are semimicroscopic statistical objects. Microscopic Lorentz invariance survives and implies four codons mating two by two. Operationally nonlocal concepts such as energy-momentum, gauge fields, and coordinates are absent from the microscopic theory. In the simplest model all elementary processes transfer both charge and spin, the familiar neutrality of the long-range fields being an average one analogous to that of an electrolyte. e, γ, and ν codes with correct laws of transformation and propagation are given. Electromagnetic, gravitational, weak, and strong interactions are considered within this framework. A heuristic argument estimates $\tau \sim \hbar/40$ GeV. The form of the theory has been determined by internal qualitative requirements and has not been subjected to external quantitative test. The developments needed for this are mentioned. (auth)

14414 SYMMETRY BETWEEN COULOMB ATTRACTION AND REPULSION IN RADIATIVE PROCESSES. Brussaard, P.J. (Fysisch Laboratorium, Sorbonnelaan 4, Utrecht, Netherlands); Klarsfeld, S. Phys. Rev. D 9: No. 8, 2330-2339 (15 Apr 1974).

The role of analyticity in connecting attractive and repulsive orbital functions in the semiclassical theory of Coulomb excitation is reexamined in detail. It is then shown that the quantum-mechanical difference functions, which connect correspondingly the matrix elements of attractive and repulsive multipoles, can be similarly obtained by a residue calculation. The possibility of extending such relations to the relativistic Dirac case is also briefly discussed. (auth)

14415 HIGHER-ORDER CALCULATION OF TRANSMISSION BELOW THE POTENTIAL BARRIER. Wald, S.S.; Lu, P. (Department of Physics, Arizona State University, Tempe, Arizona 85281). Phys. Rev. D 9: No. 8, 2254-2258 (15 Apr 1974).

In extending the Miller-Good modified WKB approximation to include the higher-order terms, a divergence was introduced. Because of this divergence, the approximation was limited to energies above the potential barrier. By removing this divergence, the modified WKB method is no longer limited to energies above the potential barrier. In order to demonstrate this method, we calculate the transmission coefficients for energies below the peak of the potential barrier and show that the higher-order terms are essential to the approximation. (auth)

14416 SPACE-TIME CODE. V. Finkelstein, D.; Frye, G.; Susskind, L. (Belfer Graduate School of Science, Yeshiva University, New York, New York 10033). Phys. Rev. D 9: No. 8, 2231-2236 (15 Apr 1974).

The concept of a quantum dynamics is recapitulated. The Dirac equation is obtained from a pure quantum dynamics as the limit of classical time. The theory is defective in projective gauge invariance and semantic consistency, but illustrates the relation between dynamical and experimental elements of q dynamics, and is finite, Lorentz-invariant, and local. (auth)

14417 CAUSAL INTERPRETATION OF QUANTUM MECHANICS. Rybakov, Yu. P. (Moscow State Univ.). Found. Phys.; 4: No. 2, 149-161(Jun 1974).

The simplest nonlinear spinor field equation admitting regular stationary solutions is considered. Following a causal interpretation of quantum mechanics, given by de Broglie in his double solution theory, these regular solutions must be regarded as describing the internal particle structure. Using this spinor field model, an attempt is made to give a statistical description of one-particle experiments by means of a Gibbsian assemblage method. It is shown that in the limiting case of pointlike nonrelativistic particles this method is equivalent to the quantum mechanical one, that is,

the probability amplitude can be introduced satisfying all postulates of quantum mechanics. (auth)

14418 REEXAMINATION OF THE ARGUMENTS OF EINSTEIN, PODOLSKY, AND ROSEN. Moldauer, P. A. (Argonne National Lab., IL). Found. Phys.; 4: No. 2, 195-205(Jun 1974).

Verifiable physical theories can deal only with reproducible phenomena. To the extent that some objectively real aspects of quantum phenomena are inherently not reproducible, to that extent quantum theory cannot be expected to provide a complete description of reality. Einstein, Podolsky, and Rosen argued, however, that quantum mechanics does not even provide a complete description of reproducible reality. But their reasoning fails to distinguish between the "predictability" and the "predictedness" of a physical quantity. It is shown that in quantum mechanics, as in classical mechanics, predictability is not affected by a nondisturbing measurement, only predictedness is affected. Since Einstein, Podolsky, and Rosen define the (reproducible) reality of a quantity on the basis of its predictability, it was found that the quantum mechanical description of this reproducible reality is unaffected by nondisturbing measurements and does not need to be considered incomplete. (auth)

14419 FOUNDATIONS OF QUANTUM THEORY. Part I. Krips, H. (Melbourne Univ., Parkville, Australia). Found. Phys.; 4: No. 2, 181-193(Jun 1974).

The first part of a new axiomatization for quantum mechanics is described. An expression is derived for the probability associated with a particular value of a variable for a given system at some time. (auth)

14420 ERROR OF A MONTE CARLO METHOD FOR CALCULATING MULTIPLE INTEGRALS. Kondyurin, Yu. N. Zh. Vychisl. Mat. i Mat. Fiz.; 14: No. 2, 489-493(1974). (In Russian).

A statistical estimate is proposed for calculating multiple integrals. This estimate is determined as an arithmetic average from successive realizations connected with a finite homogeneous ergodic Markov chain. The accuracy and efficiency of the estimate are investigated as a function of the spectral properties of the transition matrix of the Markov chain. (tr-auth)

Quantum Field Theories

Refer also to abstracts 13862, 13908–13910, 13960, 13972, 14037, 14073, 14080, 14312, 14407, 14480, and 14481.

14421 (COO-3069-187) INVARIANT QUANTIZATION, SCALE SYMMETRY AND EUCLIDEAN FIELD THEORY. Jackiw, R. (Massachusetts Inst. of Tech., Cambridge (USA)). 1973. 21p. (DSR-77906). Dep. NTIS $4.25.

A new method of quantization developed previously is reported. It is shown that the formula for the S matrix in the approach used coincides with the conventional Feynman–Dyson expression. In addition to new canonical commutators, an unexpected interpretation for anomalous dimensions is given. Especially interesting is the application of the methods to two-dimensional field theories where it is found that the present ideas provide a bridge between the formalism of conventional field theory and that of the dual resonance model. The Virasoro algebra is derived for a large class of two-dimensional field theories, and with further hypotheses, the Hagedorn spectrum is observed. (JFP)

14422 (COO-3071-87) PRECISE VALUES FOR CRITICAL FIELDS IN QUANTUM ELECTRODYNAMICS. Soff, G.; Mueller, B.; Rafelski, J. (Pennsylvania Univ., Philadelphia (USA). Dept. of Physics). Apr 1974. 44p. Dep. NTIS $5.25.

A careful investigation of different corrections to binding energies of electrons in almost critical fields is performed. The influence of the nuclear charge parameters, nuclear mass, degree of ionization on the value of the critical charge of the nucleus is investigated quantitatively. Rather qualitative arguments are given to establish the contribution of the quantum electrodynamic corrections, which are found to be small. Some phenomenological modifications of QED are quantitatively investigated and found to be of negligible influence on the value of the critical field. For heavy-ion collisions with $Z_1 + Z_2 > Z_{cr}$ the critical separations between ions are given as results of precise solutions of the relativistic two-Coulomb center problem. Corrections due to electron–electron interaction are considered. With present theoretical accuracy the quantities $Z_{cr} = 173 \pm 2$, in the heavy ion collisions $R_{cr}(U-U) = 34.7 \pm 2$ fm and R_{cr} (U–Cf) = 47.7 ± 2 fm are found. We briefly consider the possibility of spontaneous muon production in muonic supercritical fields. (auth)

14423 (IC-74-27) COMPOSITE GAUGE FIELDS AND MODELS. Budini, P.; Furlan, P. (International Centre for Theoretical Physics, Trieste (Italy)). Apr 1974. 39p. Dep. NTIS (US Sales Only) $5.00.

After a phenomenological study of the possibility of the existence of massless composite lepton and antilepton states orginated by the lepton weak interaction Lagrangian, it is concluded that only one such composite state could exist and be strongly coupled in a unique way to the free left-handed leptons and that its quantum numbers could only be those of the photon ($j = 1,0$; $\Pi C = +1, -1$). In the frame of the unified gauge models with a lower limit for the W meson mass, a condition for its existence is that the W mass be of the order of 100 GeV. It is then shown that the composite massless field has the properties of a gauge field and its gauge transformations are deduced from those of the constituent spinor fields as a consequence of the Wilson expansion of the products of the constituent two-component canonical spinor fields. This property also applies to the case when the two-component spinor fields build up a degenerate multiplet and the corresponding gauge group is non-Abelian. The gauge fields of unified models of weak and electromagnetic interactions could then be considered as composite, with the possibility of computing some of the parameters, such as the coupling constant of the gauge fields, which are otherwise free in these models, and with the advantage of eliminating the infinities of the triangular diagrams. Parity-conserving quantum electrodynamics is obtained with a method analogous to that used in the unified gauge models; it is finite, and its regularizing length is of the order of magnitude of the square root of the Fermi coupling constant. An example of application to the Salam-Weinberg model is given, together with a rough estimate of $\sin\theta$. The possibility of a bootstrap mechanism and a dynamical symmetry breaking à la Nambu-Jona-Lasinioto substitute the Higgs mechanism is mentioned. Finally, some possibilities are suggested to explain dynamically the universality of charge quantization. (auth)

14424 (JINR-E2-7909) NONLINEAR IRREDUCIBLE FORM OF THE SCHROEDINGER EQUATION FOR THE GROUND STATE OF THE SECOND-QUANTIZED HAMILTONIAN. Zastavenko, L. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 11p. Dep. NTIS (US Sales Only) $4.00.

The Schroedinger equation determining the second-quantized Hamiltonian ground state is considered. It is stated that it is useful to transform this equation through the exponential substitution into nonlinear form for the Hamiltonian. The advantage achieved is that the coefficient functions of expansion are regular, unlike those, e.g., of another ground state representation. This advantage is rather substantial for the following reasons: It implies the irreducibility of the coefficient functions $C_{2n,r}$; the representation turns out to be the simplest possible one. The ground state energy E_0 is separated from the essential part of equations defining the coefficient functions; and it enters only the first of these equations. The excited states are defined by a given construction. (auth)

14425 (JINR-E2-8027) RENORMALIZATION GROUP FOR NONRENORMALIZABLE QFT. Blokhintsev, D. I.; Efremov, A. V.; Shirkov, D. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 18p. Dep. NTIS (US Sales Only) $4.00.

Functional equations of the renormalization group (RG) are formulated for the theories with dimensional coupling constants. Special attention is paid to the theories with the coupling constants of negative-mass dimension, which are nonrenormalizable within the usual perturbation approach. The correspondence of general solutions of the RG equation with the perturbation expansion in the ultraviolet region yields the nonanalyticity in coupling constant. A possibility of the short distance scale invariance is discussed. An additional assumption on the finite number of the invariant charges imposes limitations on the Bogolubov R-operation parameters. As an illustration of consistency of this hypothesis an exactly soluble nonrenormalizable nonrelativistic model is considered. (auth)

14426 (JINR–P2-7829) ELECTRODYNAMICS EQUATION IN SPHERICAL WORLD. Pestov, A. B.; Chernikov, N. A.; Shavochina, N. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 22p. (In Russian). Dep. NTIS (US Sales Only) $4.25.

A new method–a method of invariant box is suggested for electrodynamics. (auth)

14427 (JINR-P2-7883) SCATTERING OF LIGHT BY LIGHT IN VECTOR ELECTRODYNAMICS. Okhlopkova, V. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 25p. (In Russian). Dep. NTIS (US Sales Only) $4.25.

Expressions for the scattering amplitudes with definite polarizations in the approximation $\omega^2 \gg m^2$ are found. The asymptotic $\gamma\gamma \to \gamma\gamma$ total cross section is evaluated for the scattering of unpolarized photons. Also the forward scattering amplitudes and the differential cross section for forward scattering are obtained. (auth)

14428 CHARGE VECTOR MESONS AND ξ FORMALISM. Hsu, J.P. (The Center for Particle Theory, The University of Texas at Austin, Austin, Texas 78712). Phys. Rev. D 9: No. 4, 1113-1118 (15 Feb 1974).

We discuss a finite-ξ formalism for the electromagnetic interaction of a massive charged vector meson with an arbitrary magnetic moment κ. The theory is Lorentz-covariant, renormalizable, and gauge-invariant. We consider the case $\xi = \kappa = 1$ to show that the theory is unitary after introducing a fictitious particle and two new vertices in the theory. (auth)

14429 INCLUSIVE ANNIHILATION PROCESSES IN ϕ^4 FIELD THEORY. Mueller, A.H. (Department of Physics, Columbia University, New York, New York 10027). Phys. Rev. D 9: No. 4, 963-979 (15 Feb 1974).

The process ϕ (q) → ϕ (p) + anything, the process in ϕ^4 theory analogous to $e^+ + e^-$ → hadron + anything, is examined in ϕ^4 field theory for large values of q^2. Some heuristic arguments as to the strength of mass singularities in a particular two-particle irreducible amplitude make it possible to argue that a light-cone-like expansion exists when $q^2 \to \infty$. This light-cone expansion has virtually all of the properties of the usual light-cone expansion except that it is not an expansion in terms of invariant amplitudes associated with local operators. In case ϕ^4 theory has an eigenvalue, β (g_∞) = 0, the moments of the annihilation cross section will have a power behavior in q^2, a power unrelated to the powers of q^2 appearing in any deeply inelastic scattering process. Also, at an eigenvalue the average multiplicity of particles produced, a quantity governed by the Callan-Symanzik equation in this theory, grows like a fractional power of q^2. (auth)

14430 EXAMPLE OF SCHWINGER'S MODIFIED PROPAGATION FUNCTION. Phares, A.J. (Department of Physics, Harvard University, Cambridge, Massachusetts 02138). Phys. Rev. D 9: No. 4, 920-927 (15 Feb 1974).

The aim of this paper is to investigate a specific example of the two-point-function expression, as proposed in source theory by Schwinger, which represents the inverse modified propagation function as a spectral form. Since this expression for the propagation function most naturally (but not exclusively) refers to spin-1 particles, our program is explicitly carried out in the context of spin-1 electrodynamics, with the propagation function referring to the charged particle. The two-point transverse and longitudinal spectral weight functions are calculated in lowest order. We find that the inclusion of those contributions due to source radiation leads to spectral forms which are infrared-convergent and have non-negative spectral weight functions. Furthermore, the spectral integrals are explicitly evaluated and we see the expected rate of falloff, faster than $1/p^2$, of the propagation function at large p^2. The complex p^2 poles of the propagation function are large and shown to be physically acceptable within the framework of source theory. We also demonstrate that these results remain unaffected when magnetic and quadrupole couplings are present. (auth)

14431 THEORY OF FREE, SPIN-1/2 TACHYONS. Bandukwala, J.; Shay, D. (University of Oklahoma, Norman, Oklahoma 73069). Phys. Rev. D 9: No. 4, 889-895 (15 Feb 1974).

A quantized, spin-1/2, free-tachyon theory is developed from the Dirac equation using Tanaka's pseudoscalar Lagrangian density. The tachyon spinors are found with their orthogonality relations. The similarity between the transcendental frame for tachyons and the rest frame for tardyons is noted. Using Fermi-Dirac statistics and including negative-energy states yields a theory which reduces to the four-component neutrino theory in the massless limit. We are able to find only a conserved pseudoscalar, helicity, and a conserved axial vector, related to the energy and momentum of left- and right-handed states. Scalar and polar vector quantities are constructed but are found to either vanish or vary in time. (auth)

14432 RENORMALIZATION OF GAUGE THEORIES-UNBROKEN AND BROKEN. Lee, B.W. (National Accelerator Laboratory, Batavia, Illinois 60510). Phys. Rev. D 9: No. 4, 933-946 (15 Feb 1974).

A comprehensive discussion is given of the renormalization of gauge theories, with or without spontaneous breakdown of gauge symmetry. The present discussion makes use of the Ward-Takahashi identities for proper vertices (as opposed to the identities for Green's functions) recently derived. The following features of the present discussion are significant: (1) The present discussion applies to a very wide class of gauge conditions. (2) The present discussion applies to any gauge group and any representation of the scalar fields. (3) The renormalized S matrix is shown to be gauge-independent. (4) Dependence of counterterms on the gauge chosen is discussed. (auth)

14433 LAGRANGIAN FORMULATION FOR ARBITRARY SPIN. I. THE BOSON CASE. Singh, L.P.S.; Hagen, C.R. (Department of Physics and Astronomy, University of Rochester, Rochester, New York 14627). Phys. Rev. D 9: No. 4, 898-909 (15 Feb 1974).

An explicit form is obtained for the Langrangian of an arbitrary-spin boson field. This is achieved by introducing auxiliary field variables which are required to vanish in the free-field limit. For $s \leq 4$ the results are found to be in agreement with those obtained by Chang. Canonical commutation rules are derived and the equations of motion are brought to first-order form, thereby facilitating the introduction of minimal electromagnetic coupling. It is found that, upon taking the Galilean limit, the (6s+1) -component Galilean-invariant theory of Hagen and Hurley results. The g factor is to be 1/s, thereby confirming a long-standing conjecture. (auth)

14434 LAGRANGIAN FORMULATION FOR ARBITRARY SPIN. II. THE FERMION CASE. Singh, L.P.S.; Hagen, C.R. (Department of Physics and Astronomy, University of Rochester, New York 14627). Phys. Rev. D 9: No. 4, 910-920 (15 Feb 1974).

The Rarita-Schwinger formalism for fermion fields is brought to a Lagrangian form in the case of arbitrary spin. The requirement that all differential equations of the field should follow from the variation of an action integral necessitates the introduction of additional fields in the theory. By demanding that these auxiliary variables vanish in the case of no interaction, an explicit form is obtained for the Lagrangian. The resulting theory is found to reproduce the usual formalism in the case of spin 3/2, and turns out to be in agreement with results obtained by Chang for spin values 5/2 and 7/2. The Galilean limit of the minimally coupled equations yields the minimal Galilean-invariant theory of Hagen and Hurley. The g factor turns out to be 1/s, in accordance with a long-standing conjecture. (auth)

14435 APPLICATION OF CONFORMAL SYMMETRY TO QUANTUM ELECTRODYNAMICS. Christ, N. (Columbia University, New York, New York 10027). Phys. Rev. D 9: No. 4, 946-955 (15 Feb 1974).

Conformal symmetry is used to determine the position-space vertex function $\Gamma_\lambda(x, y; z)$ of massless quantum electrodynamics in terms of the current-current correlation function $\pi_{\mu\nu}(x, y)$ and coefficients E_1 and E_2 appearing in the Wilson expansion of the product $\bar{\psi}$ (y) ψ (x) of Fermi fields. This relationship holds order by order in perturbation theory for graphs containing a single electron line, evaluated in a special position-dependent gauge. The relationship provides an explicit and perhaps simplified method for computing the vacuum-polarization amplitude $F_1(\alpha)$ and is used to analyze the behavior of single-electron-loop amplitudes in quantum electrodynamics for values of the coupling constant α near a zero of $F_1(\alpha)$. (auth)

14436 PART I. BETHE-SALPETER EQUATION AND ITS SOLUTIONS IN THE INFINITE-MOMENTUM LIMIT. Part II. Radial Effects in the Symmetric Quark Model. De, T. College Park, MD; Univ. of Maryland (1973). University Microfilms.

Thesis (Ph. D.).

The properties of the bound-state Bethe-Salpeter equation and its solutions in the infinite-momentum limit are discussed. It is first shown that the Bethe-Salpeter Green's function exhibits a δ-function-like Lorentz contraction in the high momentum limit. This contraction property is carried over to the bound-state wave function through the integral equation. It is then shown that, as a consequence, the reduced wave function satisfies an Euclidean three-dimensional integral equation. A partial-wave decomposition is first made for this integral equation, which is 0(3)-invariant. A variational method is next developed for solving the eigenvalue problem corresponding to the resulting radial equation. The solutions give a bound-state-mass versus coupling constant relation different from that of the solutions obtained by the conventional 0(4)-method. Conditions under which the bound-state Bethe-Salpeter equation can be further reduced in the infinite-momentum limit are then discussed and a two-dimensional Schrödinger-like equation is obtained. The solution of the eigenvalue problem corresponding to this new equation leads to a mass-coupling constant relation very similar to the one obtained in the three-dimensional case. Effects of the radial wave functions on the mass spectra are studied for the nonstrange baryons in the harmonic oscillator symmetric quark model. Rotational energy levels are calculated and they are found to be in agreement with the energy levels in the observed mass spectra of the baryons. Relativistic perturbative effects which vanish in the large quark-mass limit are also calculated. These effects are obtained in the framework of the bound-state Bethe-Salpeter equation and amount to anharmonic corrections to the mass spectra. The lower bound on the quark mass is thus estimated to be approximately 1.5 GeV. (Diss. Abstr. Int., B)

14437 ASYMPTOTIC RESULTS IN FIELD THEORY. Cahalan, R. F. Urbana, IL; Univ. of Illinois (1973). 133p. University Microfilms Order No. 74-11,964.

Thesis (Ph. D.).

The large-momentum behavior of two different physical processes in the context of perturbative quantum field theory. The first process involves a virtual photon probing the structure of the proton due to the strong interactions. The second process involves a real photon producing a neutral vector boson, the so-called "Z^0" conjectured in certain theories of the weak interactions. In each case the well known long-range electromagnetic

interaction of the photon provides a somewhat controlled situation in which to study the short-range interactions. The structure of the proton can certainly not be accurately described in the simplified perturbative framework. Nevertheless, one can obtain some qualitative understanding of the rapid damping of the proton's electromagnetic form factor. The Z^0 production can be accurately described, but the cross section is so strongly suppressed that the existence of the Z^0 is not likely to be established in this reaction. However, some simple features are again found which add to the qualitative understanding of photoproduction. The great successes of quantum electrodynamics have yet to be even approached in any study of the short-range interactions. This work is to be viewed as part of the general accumulation of experience, prior to any true theory of the short-range interactions. (Diss. Abstr. Int., B)

14438 PROBLEMS IN NULL PLANE QUANTUM ELECTRODYNAMICS. Ten Eyck, J. H. New York; Syracuse Univ. (1973). 87p. University Microfilms Order No. 74-10,182.

Thesis (Ph. D.).

The physical equivalence of null plane quantum electrodynamics in the null plane gauge with that of the conventional one in the Coulomb gauge is proven. It is shown that both formulations give the same S-matrix by proving that the field equations and commutation relations in the Heisenberg picture are equivalent in the two cases. This is done indirectly by transforming to the interaction picture and performing a gauge transformation on the free fields. It is required that the free fields in the interaction picture to be defined on a test function space that corresponds physically to no photons propagating along one arbitrarily chosen direction. The results are thus obtained formally and to all orders of perturbation theory. There is no need that the theory first be renormalized before equivalence can be shown. Equivalence is shown explicitly to second order for several familiar processes. The question of proper ordering for the null Hamiltonian is discussed and covariant Feynman rules for null plane quantum electrodynamics are given. These rules are used to calculate the Coulomb scattering cross section to second order in the new formulation, and obtain agreement with the usual result. (Diss. Abstr. Int., B)

14439 DIVERGENCE-FREE FEYNMAN-PARAMETRIC INTEGRALS. Cvitanovic, P. Ithaca, NY; Cornell University (1973). 111p. University Microfilms Order No. 74-7186.

Thesis (Ph. D.).

Concise and practical formulas for Feynman-parametric integrals are assembled and presented in the form of Feynman-Dyson rules in parametric space. These rules enable one to write down S-matrix elements directly in terms of some parametric functions. The study of the singularities of such Feynman-parametric integrals leads to methods for removal of all leading ultraviolet and infrared divergences. The finite remainders are then incorporated into the renormalization scheme. These integrals are particularly suitable for numerical integration. (Diss. Abstr. Int., B)

14440 PATH INDEPENDENCE AND CHARGE QUANTIZATION. Ross, D. K. (Iowa State Univ., Ames). J. Phys., A (London); 7: No. 6, 705-709(11 Apr 1974).

It is shown that if quantum electrodynamics is assumed to be manifestly gauge independent and path independent then electric charge must be quantized. (auth)

14441 DO MASSIVE BRANS–DICKE THEORIES OF GRAVITATION IMITATE BRANS–DICKE THEORIES WITH NONZERO DIVERGENCE OF ENERGY-MOMENTUM TENSOR? Smalley, L. L. (Univ. of Alabama, Huntsville). Lett. Nuovo Cim.; 10: No. 6, 231-234(8 Jun 1974).

From the study it was concluded that the assumption of a nonzero divergence for $T^{\mu\nu}$ (or equivalently the introduction of sources) formally imitates a massive Brans–Dicke and satisfies a previous condition that the theory be indistinguishable with the classical test of the Einstein theory. Also although it was previously shown that the modified Brans–Dicke theory agrees with the classical test when the scalar field parameter $= -\frac{1}{4}(W+1)^{-1}$. (JFP)

14442 COMMENTS ON FURTHER REMARKS ON THE PRINCIPLE OF VIRTUAL POWER. Haus, H. A.; Kong, J. A.; Penfield, P. Jr. (Massachusetts Inst. of Tech., Cambridge). Lett. Nuovo Cim.; 10: No. 6, 222-226(8 Jun 1974).

A reply is made to objections to a previous work on the principle of virtual power. The omission of the application of special relativity only to inertial frames, the relative velocities of which are constants is mainly discussed. (auth)

14443 SELF-CONSISTENT FORMULATION OF LOCAL FIELD THEORY. II. Hosoya, A. (Osaka Univ.); Taguchi, Y.; Yamamoto, K. Progr. Theor. Phys. (Kyoto); 50: No. 6, 2040-2047(Dec 1973).

It is shown that, so far as the one-loop diagram is concerned, the physical amplitude obtained in a theory previously presented is equivalent to that of the dimensional regularization scheme of 't Hooft and Veltman. This equivalence is used for the proof of the Ward-Takahashi identity, unitarity and causality. (auth)

14444 SOLITARY WAVES IN NONLINEAR FIELD THEORIES. Burt, P.B. (Department of Physics and Astronomy, Clemson University, Clemson, South Carolina 29631). Phys. Rev. Lett. 32: No. 19, 1080-1081 (13 May 1974).

Solitary wave solutions of field equations of the form $\partial_\mu \partial^\mu \phi + m^2\phi + \alpha\phi^{2p+1} + \lambda\phi^{4p+1} = 0$, with $p \neq 0, -1/2, -1$, are developed. For vanishing interaction the solutions reduced to positive- or negative-frequency plane-wave solutions of the Klein–Gordon equation. (auth)

14445 HIGH-ENERGY BEHAVIOR OF NON-ABELIAN GAUGE THEORIES. Nieh, H.T. (Institute for Theoretical Physics, State University of New York at Stony Brook, Stony Brook, New York 11790); Yao, Y. Phys. Rev. Lett. 32: No. 19, 1074-1076 (13 May 1974).

The fermion–fermion scattering amplitude in non-Abelian gauge theories is calculated in the approximation of keeping only the leading logarithmic terms at high energy, up to eighth order in the coupling constant. The high-energy behavior of the calculated scattering amplitude is drastically different from the results obtained in other renormalizable field theories, e.g., the ϕ^3 theory and quantum electrodynamics. (auth)

14446 THEORY OF MASSIVE AND MASSLESS YANG-MILLS FIELDS. Hsu, J.P.; Sudarshan, E.C.G. (Center for Particle Theory, The University of Texas at Austin, Austin, Texas 78712). Phys. Rev. D 9: No. 6, 1678-1686 (15 Mar 1974).

Introducing the Lagrangian multiplier field χ (x), a canonical formalism for the Yang–Mills fields $f_\mu(x)$ with mass $M \geq 0$ is proposed within the framework of an indefinite-metric quantum field theory. The formalism for the massive f_μ has a well-defined zero-mass limit, and the reduction of the physical components of f_μ as $M \to 0$ is embodied in an elegant way. Using the field equation for χ (x) and the path integral, we find that the "extra" factor in the amplitude due to the interaction of χ (x) in the intermediate states is $[\det(1+(\Box+M^2)^{-1} g\partial\mu \times \partial^\mu)^{-1}]^{1/2}$ $\equiv D_M^{1/2}$ for the massive f_μ, and that the extra factor is $D_{M=0}^{-1}$ for the massless f_μ because of their different degrees of observable freedom. Thus, the resultant rules for the Feynman diagrams for $M>0$ and $M=0$ are not smoothly connected. The theory is covariant, renormalizable, and unitary after the extra parts are removed from the amplitudes. The problems of unitarization and renormalizability are discussed. (auth)

14447 FUNCTIONAL EVALUATION OF THE EFFECTIVE POTENTIAL. Jackiw, R. (Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). Phys. Rev. D 9: No. 6, 1686-1701 (15 Mar 1974).

By use of the path-integral formulation of quantum mechanics, a series expansion for the effective potential is derived. Each order of the series corresponds to an infinite set of conventional Feynman diagrams, with a fixed number of loops. As an application of the formalism, three calculations are performed. For a set of n self-interacting scalar fields, the effective potential is computed to the two-loop approximation. Also all loops are summed in the leading logarithmic approximation when n gets large. Finally, the effective potential for scalar, massless electrodynamics is derived in an arbitrary gauge. It is found that the potential is gauge-dependent, and a specific gauge is exhibited in which all one-loop effects disappear. (auth)

14448 RADIATIVE POLARIZATION OF ELECTRONS. Schwinger, J.; Tsai, W. (Department of Physics, University of California, Los Angeles, California 90024). Phys. Rev. D 9: No. 6, 1843-1845 (15 Mar 1974).

We present a new method of calculating the radiative polarization of electrons in homogeneous magnetic fields, using the modified electron propagation function. (auth)

14449 SIXTH-ORDER ELECTRON g FACTOR: MASS-OPERATOR APPROACH. I. Milton, K.A.; Tsai, W.; DeRaad, L.L. Jr. (Department of Physics, University of California, Los Angeles, California 90024). Phys. Rev. D 9: No. 6, 1809-1813 (15 Mar 1974).

A magnetic-moment contribution, due to the sixth-order process in which the lowest-order radiative correction to the internal-electron propagator is twice iterated, is calculated analytically, using an improved mass-operator method developed by Schwinger. Our result confirms that of Levine and Roskies. (auth)

14450 SIXTH-ORDER ELECTRON g FACTOR: MASS-OPERATOR APPROACH. II. DeRaad, L.L. Jr.; Milton, K.A.; Tsai, W. (Department of Physics, University of California, Los Angeles, California 90024). Phys. Rev. D 9: No. 6, 1814-1817 (15 Mar 1974).

Continuing our analytic calculation of the sixth-order magnetic moment, we here report the results of vacuum-polarization modifications of the fourth-order ladder diagram. We obtain

$$(\tfrac{1}{2}g-1)^{\gamma}_{\text{vacuum}}=\left(\frac{a}{2\pi}\right)^{2}\left[\left(-\frac{16}{3}\pi^{2}+\frac{476}{9}\right)\ln\lambda+17\zeta(3)+16\pi^{2}\ln 2-\frac{100}{9}\pi^{2}-\frac{574}{27}\right].$$

of which only part had been previously calculated analytically. Previous numerical computations are in good agreement with this exact result. (auth)

14451 SOME DIFFERENTIAL-DIFFERENCE EQUATIONS CONTAINING BOTH ADVANCE AND RETARDATION. Schulman, L. S. (Technion-Israel Inst. of Tech., Haifa). J. Math. Phys. (N. Y.); 15: No. 3, 295-298(Mar 1974).

An explicit solution is given to the boundary value problem for certain linear differential-difference equations. The solution is well behaved even in the presence of advanced interactions. Interest in these equations arises from study of time symmetric electrodynamics. (auth)

14452 SPACELIKE REPRESENTATIONS OF THE INHOMOGENEOUS LORENTZ GROUP IN A LORENTZ BASIS. Radhakrishnan, B.; Mukunda, N. (Tata Inst. of Fundamental Research, Bombay). J. Math. Phys. (N. Y.); 15: No. 4, 477-490(Apr 1974).

The problem of introducing a Lorentz basis in a spacelike representation of the inhomogeneous Lorentz group in the spinless case, is solved by the methods of integral geometry. A new description of the representation associated with isotropic lines, which is peculiar to the spacelike case, is also given. (auth)

14453 APPLICATIONS OF THE CONCEPT OF STRENGTH OF A SYSTEM OF PARTIAL DIFFERENTIAL EQUATIONS. Mariwalla, K. H. (Inst. of Mathematical Sciences, Madras). J. Math. Phys, (N. Y.); 15: No. 4, 468-473(Apr 1974).

The concept of "strength" of a system of field equations was introduced by Einstein, and is of such generality that one can compare vastly different systems of field equations. This concept in arbitrary number of dimensions is reviewed and applied to some of the well known equations of physics. The strength, in arbitrary dimensions, of massless Klein-Gordon equations, Maxwell equations (in both potential and field formulation), and Einstein equations is calculated. Also the strength of the massless Dirac equation and Weyl's neutrino equation is determined for the case of four dimensions. It turns out that the strength for all these equations is identical for space-time dimensionality of four. Other possible applications of this concept are indicated. (auth)

14454 INVARIANT REALIZATION OF FUNCTIONAL INTEGRATION OVER A LOCAL GAUGE GROUP. Batalin, I.A.; Fradkin, E.S. (Department of Theoretical Physics, P. N. Lebedev Physical Institute, Moscow, USSR). Ann. Phys. (N.Y.) 83: No. 2, 367-426 (Apr 1974).

An invariant functional formulation of the nonlinear chiral theories as well as of their generalizations is developed. To guarantee the manifest invariance of the generating functional under different choices of the local coordinates in the inner space (parametrization) new variables are utilized which are the left side of the classical equations of motions (with or without the source). In terms of the new variables an invariant regularization is introduced and an invariant perturbation theory is developed. (auth)

14455 RELATIVISTIC THEORY OF MAGNETOELASTIC INTERACTIONS. IV. Hereditary Processes. Maugin, G. A. (Univ., Paris). J. Phys., A (London); 7: No. 7, 818-837(1 May 1974).

The case of materials which exhibit hereditary- or memory-effects is examined. By requiring that the general constitutive equations for a so-called "simple" material obey different principles of formulation such as those of equi-presence, material indifference, and fading memory, and studying the restrictions placed upon the response functionals by the second principle of thermodynamics, a complete set of functional constitutive equations is derived. In particular, it is shown that the heat flux is a functional with respect to the temperature gradient. This result allows the formulation of a heat conduction law which provides a possible answer to the paradox of infinite propagation velocity of thermal disturbances in relativity. By examining the limiting case of steady-state processes, the present formulation is shown to incorporate, in a general frame, the results obtained for nonlinear elastic solids in the preceding papers of this series (Maugin. J. Phys. A. Gen. Phys; 5: 786-802 (1972), J. Phys. A. Nucl. Gen.; 6: 306-21 and 1647-66(1973)). (auth)

14456 CLASSICAL MOMENT PROBLEM AND QUANTUM FIELD THEORIES IN TWO SPACE-TIME DIMENSIONS. McClary, W. K. Toronto; Univ. of Toronto (1972). National Library of Canada, Ottawa.

Thesis (Ph. D.).

Mathematical methods mainly inspired by the classical moment problem and the theory of Jacobi matrices are used to obtain criteria for self adjointness, and methods of solving operator equations for unbounded operators. These ideas are applied to relativistic scalar quantum field theory models in two-dimensional space-time with polynomial self-interactions to give elementary proofs of the existence of such models and to calculate vacuum state vectors and energies of the locally correct Hamiltonians from the coefficients of their divergent perturbation series. The criteria for self adjointness and the results on convergence of the method of moments approximants are used to show that although the Rayleigh-Schrödinger perturbation series for the ground state energies and eigen-vectors of the space cut-off quartic and sextic field Hamiltonians (or their analogs, the x^4 and x^6 anharmonic oscillators) diverge, it is possible to construct, from quantities which occur in the series coefficients, approximants which converge to the correct results. Results of a numerical calculation of the ground state energy of the x^4 anharmonic oscillator are given. It is shown that the theorem on Stieltjes vectors can be used to prove the self adjointness of the Hamiltonian of the x^{2n} anharmonic oscillator for n = 2,3,. . . and of a momentum cut-off scaler field theory "in a box" with arbitrary positive polynomial interaction. (Diss. Abstr. Int., B)

14457 GENERALIZED FREE FIELDS AND THE REPRESENTATIONS OF WEYL GROUP. Lukierski, J. (Catholic Univ., Rio de Janeiro); Sienkiewicz, K. J. Math. Phys. (N. Y.); 15: No. 3, 344-349(Mar 1974).

The transformation properties of generalized free fields under the transformations of the Weyl group, and particularly under the subgroup of dilatations, are discussed. It is shown that there exists, for any complex value d of the dimensionality parameter, a generalized free field, defining by means of its one-particle states the suitable irreducible representation of the Weyl group. (auth)

14458 MODEL UNIFIED FIELD THEORY. Mirman, R. (Long Island Univ., Brooklyn). J. Math. Phys. (N. Y.); 15: No. 3, 374-379(Mar 1974).

The geometry of space is probed by using a quantum mechanical wave function, which allows the introduction of the ordinary curvature tensor, and also provides room for a vector which is identified with the electromagnetic vector potential. The coordinates of space are taken as complex. Thus the electromagnetic field is geometrized and its presence is found to affect the gravitational field equations. (auth)

14459 RENORMALIZED NUMBER OPERATORS. Fabrey, J. D. (Univ. of North Carolina, Chapel Hill). J. Math. Phys. (N. Y.); 15: No. 3, 334-337(Mar 1974).

A number operator for a Weyl system is called renormalized essentially if it is obtained from the total number operator by subtraction of a (possibly infinite) constant (in exponentiated form). Necessary and sufficient conditions for the existence of a renormalized number operator are obtained. (auth)

14460 CONSISTENCY OF THE ANOMALOUS-MAGNETIC-MOMENT COUPLING OF A VECTOR-MESON FIELD. Hagen, C.R. (Department of Physics and Astronomy, University of Rochester, Rochester, New York 14627). Phys. Rev. D 9: No. 2, 498-499 (15 Jan 1974).

It is shown that when both the electromagnetic field and the vector-meson field are quantized in the presence of an anomalous-magnetic-moment interaction the energy density of the combined system is positive-definite and satisfies the Dirac-Schwinger covariance condition. This result shows that the validity of a recent suggestion of noncausal behavior in such a theory does not extend to the fully quantized case. (auth)

14461 QUASICANONICAL QUANTUM FIELD THEORY. Brandt, R.A. (Department of Physics, New York University, New York, New York 10003); Wing-Chiu, N. Phys. Rev. D 9: No. 2, 373-386 (15 Jan 1974).

We call a quantum-field-theory model quasicanonical if it is defined by canonical equal-time field commutation relations (e.g., $[\phi(x),\dot{\Phi}(0)]\delta(x^0)=-i\delta^4(x)$) and local field equations [e.g., $\Box\phi(x)=\lambda J(x)$], and is locally invariant to scale transformations [e.g., $\phi(x)\to\rho\phi(\rho x)$]. [These requirements are not consistent if the model is purely canonical, i.e., if J(x) is the simple Wick product $:\phi^3(x):$.] Canonical Bjorken scaling is valid on such models provided that the field equations are also locally invariant to R transformations [$\phi(x)\to\phi(x)+r$] and the physical currents are R-invariant. We discuss here further properties and consequences of these models. (a) We incorporate positivity and R-invariance restrictions on light-cone expansions and deduce the form of the consequent bilocal operators [e.g., $\int da\ \sigma(a):\phi(ax)\phi(0):$]. (b) We exhibit a Hamiltonian formulation of the theory, both in the massless and massive cases. (c) We show that the theory is locally conformal- and inversion- [$\phi(x)\to(x^2)^{-1}\phi(-x/x^2)$] invariant. These symmetries are spontaneously broken. (d) We discuss the implications of the model for deep-inelastic electron-positron annihilation. Exact scaling is obtained. (e) We study the possible low-energy consequences of the (spontaneously broken) R symmetry.

These include the PCAC (partial conservation of axial-vector current) consistency conditions and the Gell-Mann charge algebra. (f) We consider the arguments for and consequences of a spontaneous breakdown of the dilatation symmetry. (auth)

14462 SIMPLE CONNECTION BETWEEN COVARIANT FEYNMAN FORMALISM AND TIME-ORDERED PERTURBATION THEORY IN THE INFINITE-MOMENTUM FRAME. Schmidt, M.G. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). Phys. Rev. D 9: No. 2, 408-415 (15 Jan 1974).

We introduce a parametrization of loop momenta which allows us to perform one of the Feynman integrations in a very transparent way. This leads to expressions which can easily be related to terms resulting from time-ordered perturbation theory in the infinite-momentum frame. To exemplify our method we consider some simple Feynman integrals. As another example we discuss the covariant expressions of Landshoff, Polkinghorne, and Short for the scaling graph and the electromagnetic form factor. We indicate how to substitute the Sudakov parametrization in their work in order to simplify their discussion and to make comparisons with the work of Gunion, Brodsky, and Blankenbecler more convenient. Finally we derive an elegant form of the bound-state Bethe-Salpeter equation in which one of the Feynman integrations is performed. (auth)

14463 STATIONARY STATES OF A SPIN-1 PARTICLE IN A HOMOGENEOUS MAGNETIC FIELD. Mathews, P.M. (Center for Particle Theory, The University of Texas at Austin, Austin, Texas 78712). Phys. Rev. D 9: No. 2, 365-369 (15 Jan 1974).

We present a simple and complete determination of the energy spectrum and eigenfunctions of a relativistic spin-1 particle with arbitrary magnetic moment in a homogeneous magnetic field. The particle is described by a four-vector field satisfying the usual second-order equation including anomalous-magnetic-moment interaction. In the light of our results and those pertaining to the case when the external field is a Coulomb field, we discuss briefly the question of consistency of the vector theory at the basic c-number level. (auth)

14464 CALLAN-SYMANZIK EQUATION AND ASYMPTOTIC BEHAVIOR IN FIELD THEORY: FORM FACTORS. Marques, G.C. (Center for Theoretical Physics, Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742 and Instituto de Fisics, Universidade de Sao Paulo, Cx. Postal 8219, Sao Paulo-SaO Paulo, Brazil). Phys. Rev. D 9: No. 2, 386-399 (15 Jan 1974).

We show that even for some external lines on the mass shell, the procedure of dropping the mass-insertion term in the Callan-Symanzik equation is justified for the form factor at high squared momentum transfer in a certain class of models. This provides a very quick method of summing leading contributions in perturbation theory, as well as summing the next-to-leading terms. (auth)

14465 SCALING IN UNIFIED GAUGE THEORIES. Bars, I.; Halpern, M.B.; Levy, D.J. (Department of Physics, University of California, Berkeley, California 94720). Phys. Rev. D 9: No. 2, 400-405 (15 Jan 1974).

The new unified gauge theories of strong, weak, and electromagnetic interactions scale in low-order perturbation theory with a nonvanishing W_1 and up to a log in νW_2. This is in contrast to "old" Yang-Mills models, and resurrects the possibility of data interpretation in terms of bosonic (hadronic) constituents. (auth)

14466 ADIABATIC REGULARIZATION OF THE ENERGY-MOMENTUM TENSOR OF A QUANTIZED FIELD IN HOMOGENEOUS SPACES. Parker, L.; Fulling, S.A. (Physics Department, University of Wisconsin-Milwaukee, Milwaukee, Wisconsin 53201). Phys. Rev. D 9: No. 2, 341-354 (15 Jan 1974).

In the theory of a quantized scalar field interacting with the classical Einstein gravitational field, the formal expression for the energy-momentum tensor has infinite expectation values. We propose a procedure for defining, in certain cosmological models, suitable finite expectation values of this tensor, when the mass of the scalar matter field does not vanish. Our method uses the decomposition of the scalar field into modes permitted by the symmetry of the models. The identification of the divergent terms, which are to be subtracted mode by mode from the formal tensor, follows in a natural manner from the identification of physically relevant creation and annihilation operators under conditions of arbitrarily slow (adiabatic) time dependence of the metric. The extension of the results to periods of strong time dependence is accomplished with the aid of the requirement that the four-divergence of the regularized energy-momentum tensor remain zero at all times. The energy-momentum tensor obtained by adiabatic regularization is the same as that obtained by the n-wave regularization procedure of Zel'dovich and Starobinsky, although the two methods are conceptually quite different. In this paper we apply the adiabatic-regularization method to the minimally coupled scalar field with positive mass in the Robertson-Walker universes. Later papers will concern extensions to conformal coupling, anisotropic metrics, and massless fields, as well as a possible physical interpretation of the regularization procedure in terms of renormalization of coupling constants in Einstein's equation. (auth)

14467 GEOMETRICAL REALIZATION OF SCALAR ELECTRODYNAMICS. Chang, L.N. (Department of Physics, University of Pennsylvania, Philadelphia, Pennsylvania 19174); Chodos, A. Phys. Rev. D 9: No. 2, 355-364 (15 Jan 1974).

The group O(5, 2) can be interpreted as the conformal group acting on a five-dimensional space. Starting with an O(5, 2) -invariant massless scalar theory in seven-dimensional space, we realize one of the O(5, 2) transformations locally by means of a seven-vector field. We then demand that the equations of motion be well defined in the projective five-dimensional space. The equations which result are the usual ones of four-dimensional massive scalar electrodynamics, with one or two intriguing differences. (auth)

14468 SPECTRAL-FUNCTION SUM RULES IN ASYMPTOTICALLY FREE THEORIES. Borchardt, S.; Mathur, V.S. (Department of Physics and Astronomy, University of Rochester, Rochester, New York 14627). Phys. Rev. D 9: No. 8, 2371-2376 (15 Apr 1974).

We show that the necessary and sufficient condition to derive Weinberg's second spectral-function sum rule within the framework of a Lagrangian theory invariant under a local non-Abelian gauge group G and the global chiral SU(2) ⊗ SU(2) group is that G should commute with SU(2) ⊗ SU(2). The SU(3) ⊗ SU(3) spectral-function sum rules for currents and sum rules involving spectral functions of scalar and pseudoscalar densities are also discussed. (auth)

14469 STRUCTURE OF THE POMERANCHUK SINGULARITY IN REGGEON FIELD THEORY. Abarbanel, H.D.I.; Bronzan, J.B. (National Accelerator Laboratory, Batavia, Illinois 60510). Phys. Rev. D 9: No. 8, 2397-2410 (15 Apr 1974).

Using the methods of the renormalization group we study the structure of Pomeranchukon Green's functions in a Reggeon calculus or Reggeon-field-theory model. We are able to determine the behavior of all Green's functions in the "infrared" limit of small Reggeon momenta and small Reggeon energy (-E=angular momentum minus one). This behavior is governed by a zero of the classic Gell-Mann-Low variety which arises when the triple-Pomeranchukon coupling is purely imaginary as suggested by Gribov's analysis of Feynman graphs in ordinary field theory. The form of the Pomeranchukon propagator dictates that the trajectory function be singular at t=0 and that a variety of scaling laws for the Green's functions be obeyed. By coupling particles into the theory, we find that total cross sections are predicted to rise as a small power of ln s, which in the model is approximately $\sigma_T(s) \sim (\ln s)^{1/6}$. (auth)

14470 GAUGE MODELS WITH APPROXIMATE SYMMETRIES. Schattner, P. (Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 01239). Phys. Rev. D 9: No. 8, 2377-2385 (15 Apr 1974).

Several examples of gauge models with perturbatively calculable approximate symmetries are presented. Although these examples are not realistic, they serve to illustrate several general features of such theories as well as to show some of the difficulties inherent in making models of this type physically acceptable. (auth)

14471 SPECTRAL FORMS FOR THREE-POINT FUNCTIONS. Schwinger, J. (University of California, Los Angeles, California 90024). Phys. Rev. D 9: No. 8, 2477-2478 (15 Apr 1974).

A triple-spectral form is exhibited in a very simple situation. (auth)

14472 EQUIVALENCE OF NULL-PLANE AND CONVENTIONAL QUANTUM ELECTRODYNAMICS. Eyck, J.H.T.; Rohrlich, F. (Department of Physics, Syracuse University, Syracuse, New York 13210). Phys. Rev. D 9: No. 8, 2237-2245 (15 Apr 1974).

We prove the physical equivalence of null-plane quantum electrodynamics in the null-plane gauge to conventional quantum electrodynamics in the Coulomb gauge. This is done formally within the framework of Feynmann-Dyson-Schwinger theory. The equivalence of the dynamical equations and of the commutation relations in the two formulations is proven in the Heisenberg picture. In the interaction picture this requires that the free fields be defined over a test-function space corresponding physically to the absence of protons propagating along one space axis (which can be chosen arbitrarily). The proof has the virtue of being based on a positive-definite Hilbert space. This is possible because the null-plane gauge, as well as the Coulomb gauge, does not require supplementary conditions on state vectors nor fields with "wrong" commutation relations. A great deal of complexity of formalism is thereby avoided. (auth)

14473 HIGGS PHENOMENA IN ASYMPTOTICALLY FREE GAUGE THEORIES. Cheng, T.P. (Department of Physics, University of Missouri at St. Louis, St. Louis, Missouri 63121); Eichten, E.; Li, L. Phys. Rev. D 9: No. 8, 2259-2273 (15 Apr 1974).

We examine in detail the possibility of using the Higgs mechanism to remove the catastrophic infrared singularities in non-Abelian gauge theories which are symptotically free. Our investigation encompasses

theories based on SU(N) or O(N) with scalars in one vector, two vector, M vector, adjoint, tensor, and adjoint plus one vector representations. We find that for these theories an S matrix, in the perturbutive sense, and asymptotic freedom can not coexist. We show that a wide class of Yukawa couplings can be ignored in studying the large-momentum properties of the scalar couplings. (auth)

14474 VACUUM STABILITY AND VACUUM EXCITATION IN A SPIN-0 FIELD THEORY. Lee, T.D.; Wick, G.C. (Columbia University, New York, New York 10027). Phys. Rev. D 9: No. 8, 2291-2316 (15 Apr 1974).

The theoretical possibility that in a limited domain in space the expectation value $< \phi (x) >$ of a neutral spin-0 field may be abnormal (that is to say quite different from its normal vacuum expectation value) is investigated. It is shown that if the ϕ^3 coupling is sufficiently large, then such a configuration can be metastable, and its physical size may become substantially greater than the usual microscopic dimension in particle physics. Furthermore, independent of the strength of the ϕ^3 coupling, if $\phi (x)$ has sufficiently strong scalar interaction with the nucleon field, the state that has an abnormal $< \phi (x)>$ inside a very heavy nucleus can become the minimum-energy state, at least within the tree approximation; in such a state, the "effective" nucleon mass inside the nucleus may be much lower than the normal value. Both possibilities may lead to physical systems that have not yet been observed. (auth)

14475 MATHEMATICAL STRUCTURE OF THE BETHE-SALPETER EQUATION FOR MASSLESS EXCHANGE REINVESTIGATED. Günther, M. (University of Cincinatti, Cincinatti, Ohio 45221). Phys. Rev. D 9: No. 8, 2411-2450 (15 Apr 1974).

Solutions of the Bethe-Salpeter (BS) equation for two scalar particles of arbitrary masses interacting through an exchange of a massless scalar particle are reinvestigated by means of a new method, applicable to the problem irrespective of the metric (Euclidian or pseudo-Euclidian) of the underlying four-momentum space. This enables one to perform a step-by-step comparison of the solving procedure as applied on the one hand to the "original" equation (with underlying pseudo-Euclidian metric), and to the corresponding Wick equation (obtained from the former by formally performing the Wick rotation without prior proof of its actual validity) on the other hand. At a certain point (compare the results of Secs. IV and V, respectively) the kernels of the appropriate transformed integral equations corresponding to the two cases become manifestly analytically different. This finding seems not only to render the Wick rotation—a posteriori—invalid, but also to preclude one—in the realistic (i.e., "original") case—from obtaining the well-known Wick-Cutkosky solutions (reproduced fully in the case of the Wick equation). Although the "original" version of the BS equation is thus found too difficult to solve exactly (due to the presence of an additional parameter in the kernel), the method developed leads in a most natural way to an exactly soluble model of the BS equation obtained by retaining the pseudo-Euclidian metric but replacing the Feynmann propagator D_F for the exchange particle by the "relativistic Coulomb" propagator $\bar{D}$ (half the difference between "advanced" and "retarded" propagators). This model exhibits a marked correspondence—in its nonrelativistic limit—with the Schrödinger solution of the Coulomb problem. It should finally be noted that our method avoids any serious expansions of the results whatsoever (partial-wave expansion included) which would otherwise tend to obscure clear-cut "analytic" conclusions by posing convergence problems, and thus aims always at obtaining a closed-form expression for the total (off mass shell) scattering amplitude. (auth)

14476 APPROXIMATE CALCULATION OF THE EIGENVALUE FUNCTION IN MASSLESS QUANTUM ELECTRODYNAMICS. Blaha, S. (Department of Physics, University of Washington, Seattle, Washington 98195). Phys. Rev. D 9: No. 8, 2246-2254 (15 Apr 1974).

We solve a vertex equation in massless quantum electrodynamics and use the results to calculate an approximation to the eigenvalue function, F_1, in the Johnson-Baker-Willey model. This approximation consists of a summation of the contributions of F_1 of all one-electron-loop diagrams in which no internal photon lines intersect (if all such lines are drawn within the electron loop). Our result reproduces the known low-order terms, $F_1 = 2/3 + \alpha/2\pi - 1/4(\alpha/2\pi)^2$ exactly. In addition we find branch-point singularities and zeros at points corresponding to values for the fine-structure constant of order unity. Nonperturbative solutions of the vertex equation and F_1 are also shown to exist. (auth)

14477 COMMENT ON THE NULL-PLANE GAUGE. Chakrabarti, A.; Darzens, C. (Centre de Physique Théorique de l'Ecole Polytechnique, 17, rue Descartes, 75230 Paris Cedex 05, France). Phys. Rev. D 9: No. 8, 2484-2488 (15 Apr 1974).

Gauge-invariant Lagrangians are studied using the method of 't Hooft and Veltman along with a particular type of noncovariant symmetry-breaking term. A limiting case corresponds to the formalism of null-plane or light-cone quantization. Ward identities and the possibility of dimensional regularization are briefly discussed. (auth)

14478 TIME, THE GRAND ILLUSION. Ellis, H. G. (Univ. of Colorado, Boulder). Found. Phys.; 4: No. 2, 311-319(Jun 1974).

The reconcilability of gravitational with electromagnetic clocks suggests that a rigorous analysis of time will provide understanding of the unity of gravity and electromagnetism. Time is found to be fundamentally a property of elementary particles, only derivatively a property of clocks. A declaration is made: that the flow of an elementary particle's time is the change of its radius, that time is therefore illusory. The de Sitter expanding universe is derived from this principle by treating elementary particles as spheres in Euclidean space. The hyperspheres of de Sitter space call up a five-dimensional metric manifold whose geometry models gravity, electromagnetism, and other phenomena tied to the structure of matter; neutrinos are provided for. Distance in this manifold is related to a secondary time, not correlated to primary time, but just as illusory. A particle's inertial rest mass is the relative rate of its two proper times; mass and charge are jointly, not individually, conserved. (auth)

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Refer also to abstracts 13406, 13864, 13868, and 14466.

14479 SPHERICALLY SYMMETRIC STATIC SPACE-TIMES WHICH ADMIT STATIONARY KILLING TENSORS OF RANK TWO. Hauser, I.; Malhiot, R.J. (Department of Physics, Illinois Institute of Technology, Chicago, Illinois 60616). J. Math. Phys. (N.Y.) 15: No. 6, 816-823 (June 1974).

All spherically symmetric static space-times for which a nonredundant stationary Killing tensor of rank two exists are found and discussed. The results include explicit forms for the line elements, the Killing tensors, and the corresponding quadratic constants of geodesic motion. Included as special cases are relativistic analogs of the Lenz vector and of the quadratic constant of the motion peculiar to the spatial harmonic oscillator. (auth)

14480 TACHYONS AND GRAVITATION. Raychaudhuri, A.K. (Physics Department, Presidency College, Calcutta 12, India). J. Math. Phys. (N.Y.) 15: No. 6, 856-856 (June 1974).

This note presents the following results: (1) In the weak field approximation, the tachyon apparently experiences a repulsion due to ordinary matter; (2) a tachyon turns back from a black hole after penetrating the Schwarzschild singularity; (3) in ever expanding isotropic universes the tachyon velocity becomes arbitrarily large at a finite time; (4) between tachyons themselves, there is apparently an attraction. (auth)

14481 INTERACTION BETWEEN SHORT GRAVITATIONAL AND ELECTROMAGNETIC WAVES IN ARBITRARY EXTERNAL ELECTROMAGNETIC FIELDS. Sibgatullin, N. R. (Moscow State Univ.). Zh. Eksp. Teor. Fiz.; 66: No. 4, 1187-1200(Apr 1974). (In Russian).

It is demonstrated that propagation of short electromagnetic and gravitational waves occurs as a process of consecutive interconversion of the waves for external electromagnetic fields whose major axes are parallel translated along the wave-carrying rays. In this case the plane of polarization of the waves does not rotate along the rays. Propagation of waves in a Nordstrem–Reisner field is analyzed. In the general case the plane of polarization of initially linearly polarized short waves rotates but the total intensity of the waves along a ray isotropic tube of flow is conserved. Propagation of short waves in a Kerr–Newman field is described. It is shown that the angle of rotation of the plane of polarization with respect to an isotropic tetrad (parallel translated along the rays) should be small compared to rotation of the tetrad itself (due to rotation of the "black hole") provided the impact parameters of the rays are large. However both angles should be comparable for near-critical impact parameters which do not lie in the equatorial plane and for finite charges of the "black hole". (auth)

14482 SCALAR-TENSOR THEORY OF GRAVITATION AND SPONTANEOUS BREAKDOWN OF SCALE INVARIANCE. Fujii, Y. (Institute of Physics, College of General Education, University of Tokyo, Komaba, Tokyo 153, Japan). Phys. Rev. D 9: No. 4, 874-876 (15 Feb 1974).

A version of Brans-Dicke theory of massive scalar and massless tensor fields is given. A connection to a spontaneously broken scale invariance is shown. (auth)

14483 PERTURBATION ANALYSIS FOR GRAVITATIONAL AND ELECTROMAGNETIC RADIATION IN A REISSNER-NORDSTRÖM GEOMETRY. Zerilli, F.J. (Astronomy Department, University of Washington, Seattle, Washington 98195). Phys. Rev. D 9: No. 4, 860-868 (15 Feb 1974).

We consider the gravitational and electromagnetic fields produced by a charged (or uncharged) test particle moving in a Reissner-Nordström geometry as perturbations on the background Reissner-Nordström geometry and its associated electric field, respectively. The gravitational perturbations are expanded in tensor harmonics in the manner of Regge and Wheeler, while the

electromagnetic field is expanded in vector harmonics. Following a previously proposed convention, we find that, in the Einstein–Maxwell system of equations, electric gravitational multipoles couple only to electric (TM) electromagnetic multipoles and similarly for magnetic multipoles. It is possible to reduce the entire Einstein–Maxwell system for each type of multipole to two second-order Schrödinger-type equations. (auth)

14484 WHY DO WE BELIEVE NEWTONIAN GRAVITATION AT LABORATORY DIMENSIONS? Long, D.R. (Physics Department, Eastern Washington State College, Cheney, Washington 99004). Phys. Rev. D 9: No. 4, 850-852 (15 Feb 1974).

Recent proposals suggest types of inverse-square-law failures which can fit known astronomical data but which exhibit readily observable effects at laboratory dimensions. It is pointed out that there is no plausible way to infer from astronomical data that Newtonian gravitation applies in the laboratory. The experimental data are examined and it is found that past G measurements in the laboratory set only very loose limits to a possible variation in G and that present technology would allow considerable improvement. (auth)

14485 MASS OF THE GRAVITON. Goldhaber, A.S.; Nieto, M.M. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87544). Phys. Rev. D 9: No. 4, 1119-1121 (15 Feb 1974).

After emphasizing that it remains an open question whether one should try to quantize gravity theory (which would mean gravitational force is propagated by a graviton particle), we nevertheless ask whether a limit can be set on the rest mass (μ_g) of the "graviton." By recalling that gravitational force is clearly exerted over large distances in systems of galaxies and is not eliminated by a graviton-mass Yukawa cutoff, we find a limit. So, although it is not known if the graviton exists, one can still say that its rest mass is less than 2×10^{-42} g. (auth)

14486 COMMUTATOR ALGEBRA OF GENERAL-RELATIVISTIC OBSERVABLES. Komar, A. (Belfer Graduate School of Science, Yeshiva University, New York, New York 10033). Phys. Rev. D 9: No. 4, 885-888 (15 Feb 1974).

Although we cannot exhibit nontrivial observables in the general theory of relativity, we exploit the fact that such observables generate invariant canonical mappings of the Einstein field equations to determine the commutator of two such observables. This is accomplished by relating the commutator of two general-relativistic observables to an invariant mapping of a linear field theory obtained by perturbing the Einstein field equations. (auth)

14487 NONLINEAR GROUP REALIZATIONS INVOLVING TWO-DIMENSIONAL SPACE-TIME SYMMETRY. Machacek, M. E. Iowa City, IA; University of Iowa (1973). 157p. University Microfilms Order No. 74-7398.

Thesis (Ph. D.).

The nonlinear group realization methods of Coleman, Wess, and Zumino are extended to include the effects of space-time symmetry in a simple two-dimensional model. Momentum and energy operators are discussed in terms of this formalism. A coset decomposition of the four-dimensional Lorentz group is made with respect to the subgroup generated by a Lorentz boost and one internal rotation. Nonlinearly transforming Goldstone fields are identified with the coset parameters in this decomposition. The physical properties of these fields are determined by the subgroup. Charge pairs ±q are found which are not scalars under the Lorentz boost. The phenomenological Lagrangian is constructed in analogy with similarly transforming four-dimensional fields and its quantization is discussed. Gauge fields are introduced into the model and the effect of the Goldstone fields upon their masses is demonstrated. The results of this study are then compared with those of previous work involving only internal symmetries and with the results of ordinary linear gauge theories. (Diss. Abstr. Int., B)

14488 PERTURBATION CALCULATION OF GRAVITATIONAL POTENTIALS. Okamura, H. (Tokyo Univ.); Ohta, T.; Kimura, T.; Hiida, K. Progr. Theor. Phys. (Kyoto); 50: No. 6, 2066-2079 (Dec 1973).

The static gravitational potential for four-body system in the order of G^2 is calculated in the quantized theory. It is derived from the S-matrix elements for scattering of four spinless particles, among which gravitons are exchanged. Feynman's and de Donder's gauges are used for graviton propagator. The potential has contributions from the transverse-traceless part of the graviton field. The potential is different from that obtained in classical theory from the physically acceptable metric tensor derived previously under new coordinate conditions. Since all other known coordinate conditions such as de Donder's ones lead to divergent metric tensor at spatial infinity in the post-post-Newtonian approximation, it is not unreasonable that the two potentials become different first in this order of approximation. (auth)

14489 GRAVITATIONAL EQUATIONS OF EINSTEIN DEDUCED RIGOROUSLY POSTULATING SOME RELATIVISTIC VERSION OF THE POISSON EQUATIONS. Bressan, A. Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur.; 53: No. 1-2, 118-126(1972). (In Italian).

The form (P) of a natural relativistic analog for Poisson's equation is stated. Then (P) is specified into a postulate in a way that is physically acceptable but rather "ad hoc". This postulate implies the Einstein gravitation equations. The form (P) is specified into a postulate that is much less comprehensive and that can be justified again, but by an essential use of the Maxwell equations, conservation equations (which also are postulated) and a postulate which is surely true and has a possibility character, so that it would not be explicitly written according to common practice. (auth)

14490 GRAVITATIONAL CHARGES AND THE QUANTIZATION OF MASS. Sivaram, C.; Sinha, K. P. (Indian Inst. of Science, Bangalore). Lett. Nuovo Cim.; 10: No. 6, 227-230(8 Jun 1974).

The quantization condition $Gm^2/c = h$ is obtained by making use of the Kerr solution to the general relativity field equations. (JFP)

14491 MODIFIED BRANS-DICKE GRAVITATIONAL THEORY WITH NONZERO DIVERGENCE OF THE ENERGY-MOMENTUM TENSOR. Smalley, L.L. (The University of Alabama in Huntsville, Huntsville, Alabama 35807). Phys. Rev. D 9: No. 6, 1635-1640 (15 Mar 1974).

The Brans-Dicke theory of gravitation is modified by assuming that the divergence of the energy-momentum tensor is proportional to the covariant derivative of the scalar curvature. No ad hoc additions to the usual Brans-Dicke field equations are required as in Rastall's modification of the Einstein theory or as in the steady-state theories, of which this is a natural possibility. Three parameters emerge from the theory: the unnormalized gravitational constant G, the usual Brans-Dicke parameter ω, and the proportionality constant σ. In the post-Newtonian approximation, these parameters can be fixed by experiment. However, there exists a certain choice of the parameters for which the theory reduces to an Einstein theory with constant scalar curvature. (auth)

14492 CLASS OF SOLUTIONS OF AXIAL-SYMMETRIC EINSTEIN-MAXWELL EQUATIONS. Wang, M.Y. (Department of Physics, University of Notre Dame, Notre Dame, Indiana 46556). Phys. Rev. D 9: No. 6, 1835-1836 (15 Mar 1974).

A class of solutions of the coupled Einstein-Maxwell field equations is found. (auth)

14493 TWO CHARGED SPINNING SOURCES IN GRAVITATIONAL EQUILIBRIUM. Spanos, T.J.T. (Theoretical Physics Institute, Department of Physics, University of Alberta, Edmonton, Alberta, Canada). Phys. Rev. D 9: No. 6, 1633-1634 (15 Mar 1974).

The explicit form of the metric corresponding to two Kerr-Newman sources in equilibrium under the balancing of their electromagnetic and gravitation forces is derived using the method of Israel, Wilson, and Perjés. The sources have arbitrary masses and arbitrary but parallel angular momenta. The condition for equilibrium without struts and magnetic poles is discussed. (auth)

14494 QUANTUM GRAVITON CREATION IN A MODEL UNIVERSE. Berger, B.K. (Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). Ann. Phys. (N.Y.) 83: No. 2, 458-490 (Apr 1974).

Quantization in the spatially inhomogeneous, anisotropic, Gowdy three-torus solution of Einstein's equations leads to the production of gravitons from empty space. The creation of pairs of gravitons occurs only in wave modes with wavelength exceeding the horizon size at an initial time. The final number of created gravitons in any mode is proportional to the number of causally unconnected regions at the initial time over the wavelength of that mode. At large times, graviton number is well defined since the solution is in WKB form. The creation process produces the anisotropic collisionless radiation identical to that discussed by Doroshkevich, Zel'dovich, and Novikov which characterizes the large time classical solution. Near the singularity, the model behaves like an empty Bianchi Type I universe at each point in space (local Kasner). The canonical methods of Arnowitt, Deser, and Misner yield a reduced Hamiltonian from which the classical equations of motion are obtained. The quantization of the rapidly varying gravitational field component resembles the procedures used by Parker or Zel'dovich et al. to study particle creation in curved spacetime. (auth)

14495 SCALAR-TENSOR THEORY OF GRAVITATION COMPATIBLE WITH MACH'S PRINCIPLE. Wycherley, D. H. Atlanta; Georgia Inst. of Technology (1974). 110p. University Microfilms Order No. 74-11,422.

Thesis (Ph. D.).

The analysis of a Mach's principle compatible scalar-tensor theory of gravitation is given. Mach's principle is discussed in detail showing that one can adopt either of two fundamentally different viewpoints as to its meaning, depending on whether it is postulated that space-time structure depends completely or only partially on the matter content of the universe. These

two viewpoints are called, respectively, the strong and weak forms of Mach's principle. It is then shown that general relativity, while compatible with the weak form, cannot be made compatible with the strong form. In order to obtain a theory which is compatible with the strong form one is led to a particular set of scalar–tensor field equations. It is shown that this clock relativity leads to the prediction of a large red shift for light approaching a galaxy from a suitably chosen companion body. It is then argued that it is possible to interpret quasars as simply the companion bodies of cosmologically local galaxies. Some of the present day quasar data are examined, and it is shown that it is quite compatible with this analysis. And moreover, since quasars are thus allowed to be "brought in" to cosmologically local distances, where no unusual (such as gravitational collapse) energy sources need be postulated, it is considered that there is definite merit in the scalar–tensor theory. (Diss. Abstr. Int., B)

14496 ROTATING CYLINDERS AND THE POSSIBILITY OF GLOBAL CAUSALITY VIOLATION. Tipler, F.J. (Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). Phys. Rev. D 9: No. 8, 2203-2206 (15 Apr 1974).

In 1836 van Stockum solved the Einstein equations $G_{\mu\nu} = -8\pi T_{\mu\nu}$ for the gravitational field of a rapidly rotating infinite cylinder. It is shown that such a field violates causality, in the sense that it allows a closed timelike line to connect any two events in spacetime. This suggests that a finite rotating cylinder would also act as a time machine. (auth)

14497 INDEX OF REFRACTION FOR SCALAR, ELECTROMAGNETIC, AND GRAVITATIONAL WAVES IN WEAK GRAVITATIONAL FIELDS. Peters, P.C. (Batelle Seattle Research Center, 4000 N.E. 41st Street, Seattle, Washington 98105). Phys. Rev. D 9: No. 8, 2207-2218 (15 Apr 1974).

We consider the solutions of the scattering of scalar, electromagnetic, and gravitational waves by the gravitational field of a single particle, for the case of small wave amplitudes and weak gravitational fields. Scatterings are considered for both incident plane waves and incident spherical waves. For plane waves incident on a thin sheet of matter composed of free particles, the superimposed wave solutions give rise to a phase change arising from the coordinate dependence of the speed of light on the gravitational potential, focusing of the incident wave by the sheet, and, in some cases, a phase change due to dispersion of the wave by the matter. For gravitational waves, the index of refraction n is given by $n-1=2\pi G\rho/\omega^2$, assuming n–1 is small, and for electromagnetic waves $n=1$ to the same order. The index of refraction for scalar waves depends on the form of the scalar–wave equation used. The generation of back-scattered waves is also treated. Calculations are repeated for spherical waves incident on a thin spherical shell of matter. The propagation of δ-function wave packets is then treated in order to show that the solutions are consistent with causality, even though, in some cases, the group velocity exceeds the velocity of light. (auth)

14498 GHOST NEUTRINOS IN GENERAL RELATIVITY. Davis, T.M.; Ray, J.R. (Department of Physics and Astronomy, Clemson University, Clemson, South Carolina 29631). Phys. Rev. D 9: No. 2, 331-333 (15 Jan 1974).

An exact solution to the Einstein–Dirac equations is presented for a static, plane-symmetric spacetime generated by neutrinos. We find the neutrino field to be nonzero and to correspond to a neutrino current along the symmetry axis of the space. The neutrinos yield a zero energy–momentum tensor and therefore the gravitational field is exactly the same as for the vacuum case. A comparison with other solutions is presented along with a discussion of the possible physical significance of this "ghost neutrino" field. (auth)

14499 HIGH-ENERGY GRAVITON BREMSSTRAHLUNG. Barker, B.M. (Department of Physics, Louisiana State University, Baton Rouge, Louisiana 70803); Gupta, S.N. Phys. Rev. D 9: No. 2, 334-338 (15 Jan 1974).

The high–energy behavior of the graviton–bremsstrahlung cross section resulting from the quantum theory of gravitation is examined. The total radiated gravitational energy and its frequency as well as angular distributions are computed for various values of the incident particle velocity. A simple high–energy formula for the total radiated gravitational energy is obtained. (auth)

14500 COVARIANCE, INVARIANCE, AND THE EQUIVALENCE OF FRAMES. Earman, J. (Univ. of Minnesota, Minneapolis). Found. Phys.; 4: No. 2, 267-289(Jun 1974).

An attempt is made to clarify a number of long-standing issues concerning the nature and status of the special and general principles of relativity in particular and symmetry or invariance principles in general. An analysis of the active and passive interpretations of symmetry operations is offered. This analysis yields an evaluation of the old covariance–invariance issue. It also demonstrates that the passive interpretation, insofar as it is not trivial, is parasitic on the active picture. Finally, the analysis shows that grave difficulties lie in the way of any attempt to generalize the special principle of relativity in a manner like the one Einstein originally proposed. (auth)

14501 GRAVITATIONAL RADIATION IN SPHERICAL COORDINATES. Kobus, J. P. Found. Phys.; 4: No. 2, 291-297 (Jun 1974).

The law of gravitation is taken in the form $R_{44} = 0$, where R_{44} is the time curvature component of the Ricci tensor. Space–time separable equations are developed in spherical coordinates for the nonlinear wave equation determined by $R_{44} = 0$. One exact solution is examined in detail. (auth)

REACTOR TECHNOLOGY AND REGULATION

Power Reactors, Non-Breeding, BWR-Type

Refer also to abstracts 14587, 14599, 14601, 14604, 14608, 14654, 14683, 14691, and 14692.

14502 (INIS-mf-1120) IRRADIATION OF FUEL WITH GADOLINIUM AS BURNABLE POISON. Charlier, A.; De Raedt, C.; Leenders, L. (Societe Belge pour l'Industrie Nucleaire, Brussels; Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). 1973. 32p. INIS.

From symposium on the results of five years of BR2 reactor utilization; Mol, Belgium (4 Dec 1973).

From early 1974 onwards a significant number of LWR type UO_2 fuel pellets with Gd_2O_3 burnable poison, characterized by various fissile and poison contents, will be irradiated in a reflector channel of BR 2. Physical and technological examinations will be carried out at various fuel and poison burn-up stages, taking advantage of all available post-irradiation examination equipment at BR 2. One of the main aims is to obtain reference data for testing the burn-up calculation procedures for burnable poison containing fuels. These irradiations in BR 2 are part of a program devoted to the study of the use of gadolinium as a burnable poison in LWR's, which also consists of experiments with $UO_2 + Gd_2O_3$ fuel in the VENUS critical facility and the irradiation of some fuel bundles with a few $UO_2 + Gd_2O_3$ rods in the DODEWAARD BWR. (auth)

14503 (INIS-mf-1128) ASSESSMENT OF THE IRRADIATION BEHAVIOR OF Pu FUELS FOR LWR'S. Bairiot, H. (Societe Belge pour l'Industrie Nucleaire, Brussels). 1973. 20p. INIS.

From symposium on the results of five years of BR2 reactor utilization; Mol, Belgium (4 Dec 1973).

As the plutonium content in mixed oxide fuels for thermal reactors is relatively small, only limited changes are expected in their behavior as compared to uranium fuels. This assumption has been successfully confirmed by experiments initiated by Belgonucleaire ten years ago on mixed oxide fuels, first with stainless steel cladding and later on with zircaloy cladding. The confidence is continuously being built up through the good behavior of more than 800 rods irradiated in various power reactors (BR 3, Dodewaard, Garigliano). About 40 irradiation experiments in the BR 2 reactor are described. The objectives, the experimental approach and the investigated parameters of the demonstration programme are described; e.g. most of the rods are irradiated in typical LWR conditions, but special attention is also paid to determine the operational limits. Reliability, fabrication costs and flexibility to meet various requirements or to modify some objectives were the main guidelines; these features provide the necessary basis for improving fuel specifications and for evaluating the manufacturing variables of the industrial products. (auth)

14504 OPERATING CHARACTERISTICS OF A BOILING WATER REACTOR DEDUCED FROM IN-CORE-MEASUREMENTS. Stegemann, D.; Gebureck, P.; Mikulski, A. T.; Seifritz, W. (Technical Univ., Hanover). pp 15.1-15.17 of Power Plant Dynamics, Control, and Testing. Knoxville, TN; Univ. of Tennessee (1973).

From an applications symposium on power plant dynamics, control and testing; Knoxville, Tennessee, USA (8 Oct 1973). See CONF-731021-.

A review of cooperative activities performed to deduce the operating characteristics of the Lingen Reactor from in-core measurements is presented. The in-core instrumentation used for these measurements is described. In-core measurements include power distribution, burnup, steam void fraction, and steam-bubble-velocity. 7 references. (DCC)

14505 QUANTITATIVE DIAGNOSTIC TECHNIQUES USING EX-CORE NEUTRON DETECTORS. Thie, J. A. pp 20.1-20.18 of Power Plant Dynamics, Control, and Testing. Knoxville, TN; Univ. of Tennessee (1973).

From an applications symposium on power plant dynamics, control and testing; Knoxville, Tennessee, USA (8 Oct 1973). See CONF-731021-.

With an astute investigation one can be optimistically confident about being able to identify the principal neutron noise source in a given frequency band for a BWR or PWR. Using a model to relate this physical phenomenon to observed detector fluctuations, both theoretical and experimental intercalibrations may be obtained and subsequently used quantitatively to monitor the phenomenon. Examples given here show the ability to obtain lb/hr feedwater fluctuation, inches of core motion, and percent void carryunder in specific anomalies by using calibrated ex-core neutron noise. 10 references. (auth)

14506 REACTOR VESSEL ANNEALING APPARATUS. Katz, L. R.; Landermann, E. L.; Desmarchais, W. E. (to Westinghouse Electric Corp.). US Patent 3,809,608. 7 May 1974. Filed date 10 May 1972. 8p.

An annealing apparatus for use with an operational nuclear reactor vessel is disclosed. The apparatus is used for annealing a reactor vessel with the reactor internals, core and the primary system water removed from the vessel. The apparatus includes a support plate sized to be snugly received in the upper section of the vessel, with a seal ring being provided on the plate for forming a water tight seal in the space between the plate and the vessel. Heating means such as elongated resistance heating rods are supported by the plate and are disposed in the vessel in a heat transfer relationship with the section of the vessel immediately adjacent to the reactor core. A pump is supported on the plate for pumping the water out of the vessel after the annealing apparatus is placed in position within the vessel. The disclosed apparatus also includes reflective heat insulation means secured to the lower surface of the support plate; pressure equalizing tubing for effecting atmospheric pressure within the vessel during operation of the annealing apparatus; means arranged between the support plate and vessel for guiding the apparatus into and out of the vessel; and extendible and retractable temperature sensors arranged to contact the vessel wall during the annealing operation. (Official Gazette)

14507 EXPERIENCE WITH NUCLEAR POWER PLANT OPERATION AND FUEL. Wigger, B. (Badenwerk A. G.; Karlsruhe, Ger.). Atomwirt., Atomtech.; 19: No. 4, 204(Apr 1974). (In German).

From IAEA symposium: experiences with nuclear power plant operation and fuel; Vienna, Austria (8 Oct 1973).

Operating experience with nuclear power plants is discussed. The data obtained so far show that the availability of the plants becomes satisfactory after a certain initial period. Moreover, repair and maintenance work under complicated conditions can be carried out with greater speed and safety with increasing operating experience. (GE)

14508 EXPERIENCE WITH FUEL ELEMENTS. Schwarz, E. R. (Energie-Versorgung Schwaben A. G., Stuttgart). At. Strom; 20: No. 3/4, 30-31(Mar 1974). (In German).

From IAEA symposium: experience from operation and fueling of nuclear power plants; Vienna, Austria (8 Oct 1973).

A summary of the papers presented at the Oct. 73 IAEA Conference in Vienna is given. The main emphasis is on the experience gained in the use of fuel elements for PWRs and BWRs, but GCRs and heavy water moderated reactors are also discussed. (GE)

Power Reactors, Non-Breeding, PWR-Type

Refer also to abstracts 14502, 14503, 14505–14508, 14580, 14581, 14583, 14584, 14592, 14593, 14599, 14601, 14604, 14649, 14655, 14679, 14680, and 14684.

14509 (MRR-102) APPLICATION OF DIFFERENT NUMERICAL INTEGRATION METHODS IN THE BLOW-DOWN CODE BRUCH-D. Vojtek, I. (Technische Univ. Muenchen, Garching (F. R. Germany). Lab. fuer Reaktorregelung und Anlagensicherung). Mar 1972. vp. INIS.

The problems of numerical integration of the system of first order differential equations which describes time changes of pressures, masses, enthalpies and mass flows during a loss-of-coolant accident are described. Such a system is contained in computer code BRUCH-D (digital program established for the PWR blowdown investigation). Four different numerical integration methods are used for the solution of that system. The results are compared and one of the applied methods has been improved to yield better accuracy of results with even less computer time needed for the calculation. (GE)

14510 (ORNL-TM-4515) ESTIMATED QUANTITIES OF MATERIALS CONTAINED IN A 1000-MW(e) PWR POWER PLANT. Bryan, R. H.; Dudley, I. T. (Oak Ridge National Lab., Tenn.

(USA)). Jun 1974. Contract W-7405-eng-26. 51p. Dep. NTIS $5.75.

The quantities of materials contained in a typical 1000-MW(e) pressurized-water reactor power plant have been estimated in detail. Reference plant features, methods used in making the estimate, accuracy of the estimates, and accounting system are discussed. Estimated quantities of the composite materials and their constituents are summarized and are also presented in detail for each portion of the power plant. (auth)

14511 NON-DESTRUCTIVE DETERMINATION OF COMPLETE FUEL ASSEMBLY BURN-UP OF THE RHEINSBERG NUCLEAR POWER PLANT. Graber, H.; Hofmann, G.; Nagel, S. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie; 17: No. 3, 73-80(Mar 1974). (In German).

Non-destructive measurements by means of an experimental arrangement located in the Rheinsberg nuclear power plant have been performed for determining the absolute burnup value of the VVER-2 reactor complete fuel assemblies. The assemblies of such kind are characterized by big geometrical dimensions, a great number of fuel rods, and the high contribution of bred plutonium isotopes to burnup. From these peculiarities special problems arise in carrying out the experiments and analyzing the experimental data. This is, in particular, valid for the construction of the collimator system and calibration of the measuring apparatus as well as for calculating factors to correct both the γ-ray selfabsorption inside the assemblies and the effect the history of irradiation has on fission product concentration. An estimation of the error performed with respect to the above mentioned peculiarities shows the absolute burnup value of an investigated part of the assembly determined by the fission product ^{137}Cs to have an uncertainty of about ±8%; in the case of relative measurements this uncertainty amounts to about ±3 to ±5%. Results obtained in investigating some selected fuel assemblies are included. 16 references. (auth)

14512 NOISE AND VIBRATION MONITORING TECHNIQUES OF AN OPERATIONAL NUCLEAR STEAM SYSTEM. Huzdovich, J. M.; Simonis, J. C.; Thoren, D. E.; Zigler, G. L. (Babcock and Wilcox, Lynchburg, VA). pp 28.1-28.10 of Power Plant Dynamics, Control, and Testing. Knoxville, TN; Univ. of Tennessee (1973).

From an applications symposium on power plant dynamics, control and testing; Knoxville, Tennessee, USA (8 Oct 1973). See CONF-731021-.

The noise and vibration monitoring techniques used during the power escalation testing sequence of the Oconee Unit 1 Nuclear Steam System (NSS) are described. Described are selection criteria of the two types of transducers used, non-contacting displacement sensors and accelerometers, their principle of operation, the mounting techniques and signal conditioning used, and their method of calibration. The sensor signal interpretation techniques described are: signal amplitude, spectrum analysis, carrier demodulation, signal correlation, and audio monitoring. 9 references. (auth)

14513 DEVELOPMENT OF A 17 × 17 FUEL ASSEMBLY FOR PWRs. Nakazatos, S. (Westinghouse Electric Corp., Cheswick, PA). Nucl. Eng. Int.; 19: No. 216, 406-410(May 1974).

The development of PWR fuel is outlined and a description is given of the 17 × 17 array fuel design which is an extrapolation of the currently operating 15 × 15 design. This assembly permits a reduction in the average power in the reactor core and in the linear power rating of the fuel rod. Details are given of the mechanical design, development, and testing of the fuel component and prototype assembly. (UK)

14514 CALVERT CLIFFS NUCLEAR POWER PLANT. McGowan, G. V. (Baltimore Gas and Electric Co.). Nucl. Eng. Int.; 19: No. 216, 389-400(May 1974).

A survey is presented of the nuclear power plant at Calvert Cliffs, Maryland, a PWR type of two 800 MW(e) units. The background to the project, the history of the licensing, and the environmental procedures adopted are briefly described. More detailed descriptions are given of the nuclear steam supply system, procedures for in-service inspection, and of a system developed for the monitoring of loose parts. A brief outline is also given of an analysis of postulated pipe ruptures of high-energy fluid lines outside the containment structure, and of the subsequent modifications performed. A colored pull-out wall chart is included in the survey. This shows a cut-away drawing of the reactor and includes a list of parameters. (UK)

14515 REMARKS TO THE ACTIVITY BUILD-UP IN THE PRIMARY COOLANT LOOP OF PRESSURIZED WATER REACTORS. Bosholm, J. (Ingenieurhochschule, Zittau, Ger.). Kernenergie; 17: No. 3, 114-117(Apr 1974). (In German).

Different mobilities of the individual alloying constituents in oxides with spinel lattice give rise to their segregation in the corrosion layer. This conception gives the basis of discussing the mechanism of activity build-up and possibilities of influencing it. 21 references. (auth)

14516 EFFECT OF SURFACE BOILING ON THE NOISE POWER SPECTRUM OF A PRESSURIZED WATER REACTOR. Meyer, K. (Ingenieurhochschule, Zittau, Ger.). Kernenergie; 17: No. 4, 106-108(Apr 1974). (In German).

The formation of the noise power spectrum of a pressurized water reactor due to reactivity fluctuations as a result of the formation and departure of steam bubbles has been calculated on the basis of point kinetics, provided that sufficiently low formation of bubbles takes place which does not affect coolant flow in the reactor core, and the density fluctuations of which may be described by means of fluctuations of a Poisson distribution. Assuming plausible times for the nucleation of single bubbles frequency response curves will be obtained which correspond qualitatively to the characteristics measured. Possible generalization of the questions under consideration is briefly discussed. 6 references. (auth)

14517 ANALYSIS OF THE CAUSES OF VIBRATIONS OF EQUIPMENT IN THE FIRST LOOP OF NUCLEAR POWER STATIONS WITH WATER-MODERATED WATER-COOLED REACTORS. Samarin, A. A.; Nozdrin, G. N. (All-Union Heat Engineering Inst., Moscow). Therm. Eng. (USSR) (Engl. Transl.); 20: No. 6, 55-58(Jun 1973).

Translated from Teploenergetika; 20: No. 6, 40-42(1973).

14518 NUMERICAL STUDIES IN THE ACCURACY OF CONVENTIONAL COARSE MESH METHODS FOR PWR's. Fayers, F. J.; Nash, G. (Atomic Energy Establishment, Winfrith, Eng.). Ann. Nucl. Sci. Eng.; 1: No. 3, 185-202(Mar 1974).

The application of conventional coarse mesh methods to the prediction of power distributions in PWR's is discussed. Questions relating to choice of homogenization procedure, effects of mesh arrangement and spacing, and also energy group representation are examined. Numerical studies on supercells and a start of life condition for a large whole core indicate that straightforward application of a conventional coarse mesh procedure should be capable of achieving about 3% accuracy in local rating. The effects of power-dependent feedbacks and the importance of three-dimensional calculations are illustrated. (auth)

Power Reactors, Non-Breeding, Graphite Moderated

Refer also to abstracts 13082, 14594, 14648, 14651, 14658, and 14690.

14519 (EIR-257) POSSIBILITY OF CONTINUOUS IN-CORE GASEOUS EXTRACTION OF VOLATILE FISSION PRODUCTS IN A MOLTEN FUEL REACTOR. Taube, M. (Eidenoessisches Inst. fuer Reaktorforschung, Wuerenlingen (Switzerland)). May 1974. 35p. Dep. NTIS (US Sales Only) $4.75.

A system of continuous gas purging of a reactor core for removal of volatile fission products from the molten chloride fuel is discussed and calculations based on a computer program are shown. The results indicate that the precursors of the delayed neutrons nearly all remain in the core, but Iodine-131 in the steady-state core is reduced approximately by a factor of 1000. Cesium-137 concentration in the core decreases only by a factor 7, but the volatility is relatively low due to the chloride. Cesium isotopes 135 and 133 can be separated from Cs-137, which simplifies the handling of the Cs-137. Xenon isotopes are extensively extracted. These effects result in a significant improvement in the safety of this reactor type in the case of a core accident. (auth)

14520 (GA-A-12795) INDEPENDENT REVIEW OF THE PHYSICS DESIGN OF THE RELOAD 1 FUEL SEGMENT OF THE PSC CORE. Apperson, C.; Davison, W. (General Atomic Co., San Diego, Calif. (USA)). Mar 1974. Contract AT(04-3)-633. 38p. Dep. NTIS $4.00.

In accordance with quality assurance criteria procedures, an independent review of the physics design of the reload 1 fuel loadings for the Fort St. Vrain reactor has been conducted. The results obtained during this review are in good agreement with the values obtained during the reactor core design. (auth)

14521 (INIS-mf-1123) COATED PARTICLE IRRADIATION AT BR2 FOR THE GERMAN HTR-FUEL DEVELOPMENT. Baier, J.; Mueller, H.; Pott, G. (Kernforschungsanlage Juelich G.m.b.H. (F.R. Germany). Inst. fuer Reaktorbrennelemente). 1973. 16p. INIS.

From symposium on the results of five years of BR2 reactor utilization; Mol, Belgium (4 Dec 1973).

In the BR2, Mol, the object of most of the previous irradiation experiments was to optimize layer thicknesses and material properties of coated particles. In those experiments particles were inserted loosely in graphite crucibles or pressed into 2 mm thick graphite matrix coupons. Temperature histories simulated peak conditions of the respective HTR and the target values of these experiments correspond to the maximum design figures. Difficulties arose with testing highly enriched (>90% U-235) feed particles. To avoid too high initial particle rating all our feed particle tests incorporated a silver shield for the first 100 days for reducing the thermal neutron flux. (INIS)

14522 (INIS-mf-1167) FACILITIES FOR HIGH-TEMPERATURE REACTOR STUDIES AT HARWELL. Williams, J. (comp.). (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). 1973. 37p. INIS.

Harwell has been engaged in work in support of the High Temperature Reactor Programme in the UK for many years and has thus built up a whole range of facilities and expertise which can be made available to external customers. The specific areas of work are: testing of graphite, fuel particles and fuel assemblies in Material Testing Reactors (such as DIDO and PLUTO) and Dounreay Fast Reactor in both static rigs and gas cooled loops; complete range of post-irradiation examination covering all aspects of mechanical and fission product behaviour (this covers the whole spectrum from dealing with individual particles to complete fuel pins); and supporting laboratory studies and assessment studies on particle endurance and fission product behaviour. Some of the facilities available for this work are described. (auth)

14523 (RD/B/N-2857) VARIATION OF STANTON NUMBER WITH PRANDTL NUMBER FOR ROUGH AND SMOOTH SURFACES AT GAS-COOLED REACTOR CONDITIONS. Lyall, H. G.; Pirie, M. A. M. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). Feb 1974. 14p. (RPC/HT/N-(73)29). Dep. NTIS (US Sales Only) $4.00.

Consideration is given to heat transfer from rough and smooth surfaces in the range of Prandtl number and Reynolds number normally obtained in gas-cooled nuclear reactors, and for values of the surface-to-bulk temperature ratio close to unity. It is shown that for both types of surface Stanton number varies as Prandtl number to the power −0.4, rather than the widely-used −0.6. A modified Reynolds analogy, $St = 0.98(f/2)Pr^{-0.4}$ is shown to correlate the smooth tube data very well in this range. It gives results over 10% lower than the Dittus-Boelter correlation. At much lower Reynolds number, such as might occur in a reactor under fault conditions, a weaker Prandtl-number dependency occurs with rough surfaces, but a stronger one with smooth surfaces. This phenomenon is explained qualitatively. (auth)

14524 (WASH-1230(Vol.5)) HIGH TEMPERATURE GAS-COOLED REACTOR PLANT. Volume V. 770-MWe Central Station Power Plants Investment Cost Study. (United Engineers and Constructors, Inc., Philadelphia, Pa. (USA)). Dec 1973. Contract AT(11-1)-2226. 328p. Dep. NTIS $19.50.

An investment cost study on a 770 MW(e) nominally rated High Temperature Gas-Cooled Reactor (HTGR) central station power plant was conducted for the purpose of presenting detailed cost information which could be used in making cost comparisons, evaluations, and projections relative to alternative types of nuclear and fossil power plants. (DG)

14525 PLANT SIMULATION FOR TRANSIENT ANALYSES OF A VERY HIGH TEMPERATURE GAS COOLED REACTOR PLANT. Ezaki, M. (Japan Atomic Energy Research Inst., Tokai); Mitake, S.; Sato, K.; Shimazu, A. pp 11.1-11.40 of Power Plant Dynamics, Control, and Testing. Knoxville, TN; Univ. of Tennessee (1973).

From an applications symposium on power plant dynamics, control and testing; Knoxville, Tennessee, USA (8 Oct 1973). See CONF-731021-.

A study on the application of VHTGR to steel-making and to closed-cycle gas turbine system is being developed in JAERI. The proposed system is of 50 MW total thermal output with the reactor outlet temperature of 1,000°C, and consists of two main coolant loops. One loop is for main heat sink components, such as a steam generator and a steam reformer which is a chemical reactor producing a hydrogen rich synthesis gas for direct iron ore reduction or industrial processes. The other loop is for testing various components, such as a high temperature heat exchanger (reduction gas heater) and a single shaft closed-cycle gas turbine. Limited experiences were gained on the simulation of such a plant in which many components of different characteristics are combined. The basic approach of the simulation, with special emphasis on reactor safety, the plant simulation models, and the limitations of the simulation are described. The study has been performed in parallel on pure-digital and hybrid computers, and the cost and some other features are compared between the two simulation techniques. The main objective of the plant simulation is to obtain the plant dynamic behavior under abnormal and fault conditions. Therefore, first step of the study was to survey the abnormal and fault conditions in the plant, and the items of the plant faults and accidents were summarized. On each item, the required depth and range of the simulation model was assessed. From the above study, three classes of simulation model were prepared for plant dynamic analyses. Appropriate analysis models are listed for each item of plant dynamic analyses, and the basic mathematical equations are described in detail according to the three class models. 6 references. (auth)

14526 GRAPHITE FOR GAS COOLED REACTORS. Kawakami, H. (Fuji Electric Co. Ltd., Yokosuka, Japan). FAPIG (Tokyo); No. 67, 156-162(Nov 1972). (In Japanese).

Fundamental properties, radiation effects, and chemical characteristics of graphite are described. Graphite suffers radiation damage by fast neutrons and oxidation loss by the reaction with impurities in the coolant when employed as a construction material for reactor cores. Dimensional changes cause mutual interference of graphite blocks, and strength is reduced by irradiation at elevated temperatures. The important effects in reactor core design are the change in dimensions, change in thermal expansion coefficient, change in thermal conductivity, change in mechanical properties such as strength and Young's modulus, creep, and stored energy. As irradiation dosage increases, apparent density of the graphite approaches a constant value, thus graphite of proper density can be chosen to provide dimensional stability. Effects of irradiation at high temperature on the mechanical strength in particular are so important that further accumulation of data is necessary. Graphite does not react with helium coolant, but reacts with H_2O, CO_2, H_2, etc. The reaction of graphite with H_2O is described. In AGR type reactors, oxidation of graphite due to the decomposition of CO_2 by irradiation is the problem to be solved, whereas in HTR reactors, it may be conceivable that the radiation effect can reduce concentration of H_2O in the gas phase reaction, and thus limit oxidation corrosion. (JA)

14527 DRY-TYPE COOLING TOWER OF THE 300 MW THTR NUCLEAR POWER PLANT. Hirschfelder, G. Energ. Tech.; 26: No. 2, 45-49(Feb 1974). (In German).

The cooling tower is characterized by some new design features. The mechanical structure of the cooling tower shell is supported by a network of wire ropes, as this construction allows far greater dimensions. The inclined arrangement of the cooling elements within the cooling tower shell permits optimum utilization of the available space and surface and reduces the effect of cross winds. The cooling tubes and fins, made of steel and dip-galvanized to increase their corrosion resistance, are expected to have a long serviceable life. (GE)

14528 START-UP PHASE OF THTR-300. Gutsch, U.; Leithner, D.; Brandes, S.; Oppenheim, C. L. (Hochtemperatur-Reaktorbau GmbH, Mannheim, Ger.). Atomwirt., Atomtech.; 19: No. 4, 176-178(Apr 1974). (In German).

The high-temperature reactor THTR-300 presently under construction and its fuelling system are briefly described. The loading of the pebble-bed reactor comprises continuous input, reloading and removal of fuel elements as well as the handling of dummy elements and absorber balls during the start-up phase. The loading is carried out in such a way that an economical transition from primary core to equilibrium core is achieved while maintaining the physical and thermodynamical boundary conditions of the core. Costs are expected to be reduced to a minimum through an optimum utilization of the fuel elements of the first core. The computer code SUCON has been developed for the calculation of the fuel burn-up and refuelling scheme with multiple re-insertion of fuel elements. The program is briefly described and characteristic results of the start-up phase of the THTR are given. (GE)

14529 HELIUM TURBINE FOR A 1,000 MW NUCLEAR POWER PLANT. Bammert, K. (Technische Univ., Hannover); Finckh, H. H.; Trabler, M. O. Kerntechnik; 16: No. 3, 108-114 (Mar 1974). (In German).

The ever increasing demand for electrical power and the growing concern about environmental pollution are forcing the power industry to reconsider and develop power systems compatible with both power demands and environmental needs. The generation of electrical power with a gas-cooled high-temperature reactor and a direct closed-cycle helium turbine is one way to meet such requirements. One of Kraftwerk Union's design concepts for a 1,000 MW(e) closed-cycle helium turbine is described. Emphasis was placed on feasibility and cost savings as well as ease of main-

tenance and serviceability. Consideration has also been given to extrapolation of unit output. (GE)

Power Reactors, Non-Breeding, Otherwise Moderated

Refer also to abstracts 14647 and 14658.

14530 CANDU: A CANADIAN SUCCESS STORY. Griffiths, G. M. (Ministry of State for Science and Tech., Ottawa). Phys. Can.; 30: No. 1, 2-7(Jan 1974).

The history and goals of the Canadian nuclear program are outlined. The design and performance of research and power reactors is described. The advantages and disadvantages of the CANDU concept are tabulated and the implications explored for new fuel cycles and nuclear heat used for hydrogen generation and fossil fuel processing. (CA)

14531 ANALYSIS OF THE RESTRICTIONS ON RAPID CHANGES IN OUTPUT OF A TYPE A POWER PLANT RESULTING FROM THE PROPERTIES OF THE ACTIVE ZONE OF THE KS-150 REACTOR. Novak, S.; Budinsky, M. Bull. EGU; No. 78, 1-4(1973). (In Czech).

The conclusions of physical limitations of the KS-150 reactor operation are described. From the analysis was drawn that the poison by the ^{135}Xe has the greatest effect on the reactor operation. There is given a method of calculation of reactivity decrease for any time and space neutron flux distribution. Reactivity decreases for some possible operations were calculated. (auth)

14532 TRANSIENT PROCESSES IN THE PRIMARY CIRCUIT OF THE A 1 POWER PLANT AT THE ONSET OF NON-SYMMETRY IN PARALLEL OPERATION OF THE TURBOBLOWERS. Polak, V.; Ricany, J. Bull. EGU; No. 77, 23-33(1972). (In Czech).

A linear model of the A 1 nuclear power plant primary circuit dynamics is presented. It is built in such a way that transients of important parameters may be investigated in the case of the nonsymmetric performance of the coolant circulators. Two velocities (operational and accidental) of the circulator blade tilt may be chosen. 7 references. (auth)

14533 THERMOHYDRODYNAMIC INSTABILITIES IN A BOILING CHANNEL IN PARALLEL WITH A FINITE BYPASS. Tremblay, P. E. Toronto; Univ. of Toronto (1972). National Library of Canada, Ottawa.

Thesis (Ph. D.).

In connection with the problems of thermohydrodynamic instability that may be encountered under certain operating conditions in boiling-coolant nuclear reactors such as the CANDU BLW reactor, the flow instability in a single boiling channel in parallel with a finite bypass has been studied both theoretically and experimentally. In the boiling channel a one-heater geometry in annular flow and a three-heater assembly in subchannel flow have been considered. A computer code 'INSTAB' has been written to solve the one-dimensional transient conservation equations for mass, momentum, and energy by the finite difference method, taking into account the time variation of the common channel pressure drop. The code calculates the system initial conditions which could be optionally adjusted to match measured conditions. After a power perturbation and transient calculations for one and a half cycles, the code predicts the system damping and oscillating period for the specified initial conditions. After transient calculations at three different power levels, it estimates the most critical power and damping. The code also includes several optional features for making parametric studies and determining the system hydraulic characteristics. An experimental program was carried out for pressures ranging from 300 to 1000 psig, boiling channel mass fluxes ranging from 0.1 to 0.5×10^6 lb/hr-ft^2 and subcoolings between 15 and 175°F. A considerable amount of data for critical powers, oscillating periods and divergence envelopes are presented. Two levels of critical powers were observed: (1) low level, near bypass flow reversal conditions, causing oscillations termed "buoyancy" type and (2) high level, near dryout, leading the "density-wave" type of oscillation. An almost linear relationship was observed between the oscillating periods and the non-boiling length transit time. Compared to experiment, the theory agrees with measured high-level critical powers within ±3 kW/heater (2% of maximum), but underpredicts the oscillating period by 46%. In a few cases, the model was unable to predict measured oscillating conditions. The model indicated that kinetic energy or piping roughness had little effect upon system stability with the considered geometries. (Diss. Abstr. Int., B)

14534 STRESS ANALYSIS AND THE FUTURE OF NUCLEAR POWER. Perryman, E. C. W. Chalk River, Ont.; Atomic Energy of Canada Ltd. (1974). 19p.

Predictions are made as to certain engineering developments that will take place in the CANDU-PHW and CANDU system over the next 10 to 20 years. Scarcity of trained personnel and desire to decrease capital cost press for increasing size of nuclear units. Design studies are in progress for 1200 MW(e) and 2000 MW(e) units. New fuel cycles involving thorium and plutonium are under study. In the field of stress analysis, studies are under way of the creep of zirconium alloy pressure tubes. New end fittings are being developed incorporating two electron beam welds, and the allowable stress is under investigation. Much less conservative designs are in order for tube sheets, and pressure vessels are playing an increasing role in Canadian nuclear technology. Quality control is important in all of these fields and there is economic pressure to better understand maximum allowable defects. (CA)

Power Reactors, Breeding

Refer also to abstracts 13077, 13080, 14558, 14570, 14582, 14586, 14588, 14592, 14597, 14600, 14607, 14645, and 14650.

14535 (ANL-RDP-27) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT, APRIL 1974. (Argonne National Lab., Ill. (USA)). 31 May 1974. Contract W-31-109-eng-38. 139p. AT.

Highlights of project activities for April 1974 are summarized. The EBR-2 testing programs are reviewed. Studies of LMFBR components, instrumentation, fuels, materials, physics, and safety are described. Thermal effluent dispersion measurements for the Point Beach Power Reactor Unit 1 are presented. Critical experiments for the GCFR are described. (DCC)

14536 (BNWL-tr-124) CONTROL OF CONTAMINATIONS IN SODIUM LOOPS. Ullmann, H. Translated by B. G. Russell from Kernenergie; 17: No. 1, 5-10(1974). 17p. Dep. NTIS $4.00.

The use of sodium coolant technology in nuclear energy industry requires new, sensitive trace analysis and measuring methods. Special attention must be paid to further improvement in methods of monitoring the levels of oxygen, hydrogen, and carbon in the sodium. The tendency is toward the development of continuous measuring methods which detect the chemical activity (chemically active content) of these impurities. A number of analytical and measuring problems in sodium technology can be solved with conventional chemical, physical, or radiation measurement techniques. These include cover gas monitoring, the determination of many metallic and non-metallic trace impurities in the sodium, and fission-product monitoring in the sodium and the cover gas. The main features of their use in sodium technology concern the sampling techniques and sample processing, as well as radiochemical analysis at high ^{24}Na activity. The requirements, the state of the art, and the most important development trends are discussed. (auth)

14537 (CONF-740606-18) STRUCTURAL DESIGN CRITERIA FOR LMFBR COMPONENTS AND INELASTIC MATERIAL BEHAVIOR. Greenstreet, W. L.; Liu, K. C.; Pugh, C. E. (Oak Ridge National Lab., Tenn. (USA)). [nd]. 16p. Dep. NTIS $4.00.

From pressure vessels and piping-materials-nuclear conference; Miami Beach, Florida, USA (24 Jun 1974).

Constitutive equations adopted for current use in describing inelastic behavior of Types 304 and 316 stainless steel in LMFBR applications are outlined. The equations are for small deformation behavior and are based on the assumption that the total strain tensor can be expressed as the sum of elastic, plastic, and creep components. Constitutive equations appropriate to each component were identified and developed primarily on the basis of existing uniaxial test data. (auth)

14538 (GEAP-13979) STATE-OF-THE ART REPORT ON ACOUSTICAL MONITORING OF NUCLEAR REACTORS. Berg, F. H.; Boyd, L. R.; Smith, K. A.; Wallach, J. (General Electric Co., Sunnyvale, Calif. (USA). Breeder Reactor Dept.). Jul 1973. Contract AT(04-3)-893. 40p. AT.

A state-of-the-art review is presented on several LMFBR related areas within the field of acoustic monitoring. These areas are: (1) vibration monitoring; (2) boiling detection; (3) stress emission monitoring; and (4) position indication and identification. A discussion on signal processing is included. The references include both domestic and foreign literature sources. Each area is presented in light of the present thoughts and techniques in use as indicated by the literature. The state-of-the-art and limitations of these five areas are indicated. (auth)

14539 (INIS-mf-1122) PREDICTION OF THE IRRADIATION CHARACTERISTICS OF FAST REACTOR FUEL PINS TESTED IN CADMIUM SCREENED LOOPS IN BR2. Methods and Application to the Mol 7B Sodium Loop. Debrue, J.; De Raedt, C.; Maene, N. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). 1973. 36p. INIS.

From symposium on the results of five years of BR2 reactor utilization; Mol, Belgium (4 Dec 1973).

The methods used for the prediction of the irradiation conditions in BR2 are described, particularly with reference to their application to the determination of the irradiation characteristics of a cadmium screened sodium loop. The main features of the theoretical and experimental techniques are presented, as well as the interrelation which exists between the physics work and the information provided by the instrumented devices under irradiation in BR2. Typical results concerning the irradiation of 18 SNR-type fuel pins in the MOL 7B sodium loop are given, as obtained by calculation and measurements in BRO2 prior to loading the loop in the BR2. Comparison is made with the results from the thermal balance measurements on the loop under irradiation. (auth)

14540 (INIS-mf-1131) BELGIAN IRRADIATIONS OF MIXED OXIDE FUELS FOR THE SNR FAST REACTOR PROGRAM IN BR2. Michel, A. (Societe Belge pour l'Industrie Nucleaire, Brussels). 1973. 23p. INIS.

From symposium on the results of five years of BR2 reactor utilization; Mol, Belgium (4 Dec 1973).

The BR2 irradiations of fuel of the Belgian fast reactor programme have been performed under cadmium screens in four capsules (FAFNIR type) and in three consecutive loops: MFBS-4, MFBS-6 and Mol 7B. The aim, the design and the in-pile conditions of these irradiations, as well as the post-irradiation results are summarized. (auth)

14541 (JAPFNR-128) PERFORMANCE TEST OF MECHANICAL SNUBBER FOR FAST BREEDER REACTOR. Sasaki, A.; Sunakoda, K.; Uchi, T. (Sanwa Tekki Corp., Utsunomiya (Japan). Utsunomiya Works). Mar 1973. 35p. (PNC-J-231-73-1). Dep. NTIS (US Sales Only) $3.75.

For Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan).

Tests were conducted on seven types of mechanical shock absorbers designed for use on LMFBR primary coolant circuit piping. Vibration, static workability, resonance, and endurance test results are given. (DG)

14542 (JAPFNR-142) STUDY ON THE BEHAVIOR OF FISSION PRODUCTS IN SODIUM(1). First, Second, Third, and Fourth Sodium Circulation Experiments. Yamazaki, Y.; Hirano, K.; Sukegawa, T. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). May 1973. 46p. (PNC-J-250-73-20). Dep. NTIS (U. S. Sales Only) $5.50.

For Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan).

Experiments on the behavior of fission products in sodium were conducted by using the sodium in-pile loop (SIL) set in JRR-2 of JAERI. Metallic uranium plates were loaded at the top of the inpile tube and directly contacted with liquid sodium. Part of the fission products created in the fuel by neutron irradiation released from the fuel surface to sodium and circulated in the loop with sodium. The behavior of the fission products in the sodium loop was pursued by measuring the spectrum with a Ge(Li) detector through collimators and measuring delayed neutrons with a BF_3 counter above the expansion tank. The highest and lowest temperature of sodium during experiment were 500°C (fuel surface) and 130°C (outlet of cold trap), respectively. The flow rate of sodium was below 5 l/min. Main fission products detected through the experiments were ^{87}Br, ^{134}I, ^{135}I, ^{136}I, ^{140}Cs and ^{143}Ba in the main cooler; ^{87}Br, ^{89}Rb, ^{133m}Te, ^{134}Te, ^{134}I, ^{136}I, ^{138}Cs and ^{140}Cs in the sodium part of expansion tank; ^{87}Br, ^{87}Kr, ^{88}Kr, ^{88}Rb, ^{89}Kr, ^{89}Rb, ^{137}Xe and ^{138}Cs in the cover gas part of expansion tank; and ^{87}Kr, ^{88}Kr, ^{89}Kr, ^{97}Zr, ^{100}Nb, ^{133m}Te, ^{134}Te, ^{132}I, ^{133}I, ^{134}I, ^{135}I, ^{138}Xe, ^{142}Ba and ^{143}La in the cold trap. ^{143}Ce was detected in the cold trap after the shutdown on the reactor and the drainage of the sodium. ^{140}La was detected at all parts of sodium system after about a week cooling. Extremely dilute fission products in sodium adhered even on the inner wall above about 350°C as the main cooler. Considerable parts of Kr and Xe from the fuel were held in the sodium and detected on the inner wall of cold trap. The decay products of Rb and Cs were not detected except ^{142}Ba, ^{143}Ba and ^{143}La in the sodium flow line during the operation of the reactor. (auth)

14543 (NIIAR-P-191) NATURAL CIRCULATION IN PARALLEL CHANNEL SYSTEM OF NUCLEAR POWER PLANTS. Markin, S. A.; Aleksandrov, K. A.; Krasnoyarov, N. V. (Nauchno-Issledovatel'skij Inst. Atomnykh Reaktorov, Dimitrovgrad (USSR)). 1973. 32p. (In Russian). INIS.

A study of natural circulation in a system of parallel channels is important in the problem of cooling the active zone of a fast reactor during operation after an excursion. On taking into account the possibility of creating a unit with the heat transfer medium moving both from the bottom up and also from the top down in the reactor, the authors have considered the conditions for the existence of natural circulation that are possible in these cases. From the applicable mathematical model with the introduction of degrees of subcooling and of equivalents and from the cubic equation obtained thus, it is possible to determine all regions of flow which can be realized in a multichannel system and in this way to determine the regions of operating parameters, in which it is possible to trigger natural circulation. (SJR)

14544 (ORNL-4950) POST-TEST EXAMINATION OF ALCO/BLH SODIUM-HEATED STEAM GENERATOR. DeVan, J. H.; Slaughter, G. M. (comps.). (Oak Ridge National Lab., Tenn. (USA)). May 1974. Contract W-7405-eng-26. 170p. AT.

The post-test examination of the Alco/BLH sodium-heated steam generator is described. The performance testing of this steam generator at the Liquid Metal Engineering Center was terminated when water and sodium were observed to have leaked through a network of cracks in the lower tubesheet. Before this failure, leaks had also been detected in three tubes in the upper tubesheet region. The unit was delivered to Oak Ridge National Laboratory, where an extensive examination was undertaken to determine the probable cause(s) of the tubesheet failure and to discover likely reasons for the leaks that had occurred in the top tubesheet region. The results of predisassembly inspection, including leak, penetrant, and flow tests, are described. Access ports near the bottom and top of the unit were machined before disassembly to permit visual examination of the generator internals as well as to permit placement of strain gages. Extensive sectioning was performed on both the bottom and top tubesheets. The observations are discussed, and based on these, possible failure mechanisms are identified. Results of the examination of tubes, thermocouples, and other parts of the steam generator assembly are also described. (auth)

14545 (ORNL-TM-4482) FAST REACTOR ANALYTICAL SHIELDING PROGRESS REPORT FOR SEPTEMBER AND OCTOBER 1973. 189a No. 10318, Activity No. 04 40 01 03 1. Mynatt, F. R. (Oak Ridge National Lab., Tenn. (USA)). May 1974. Contract W-7405-eng-26. 77p. AT.

Analytical shielding work performed for the fast reactor program during the months of September and October consisted of calculations for both the FFTF and the CRBR plants, continued computer code development, the partial analysis of three different TSF experiments, and calculations supporting the design of a new TSR-II beam shield. In the FFTF studies, the combined effect of multiple penetrations through the reactor cavity shield was determined, additional predictions of the ^{24}Na gamma-ray dose rates in the heat exchanger vault were made, and a preliminary three-dimensional calculation of the reactor cavity fluxes produced by the FTR stored fuel was carried out. In the CRBR studies, predictions were made of the effect of stored-fuel neutrons on the response of the ex-vessel RSP detectors. The code development work centered on selecting features to be included in the DOT-IV code. The analyses for the TSF experiments consisted of calculations of the fission detector responses observed in the TSF-FTR first-fission stored-fuel experiment; calculations of the neutron fluxes measured in the TSF inconel experiment; and calculations of the energy deposition by ^{60}Co gamma rays in iron (as measured with thermoluminescent detectors). Several calculations were also performed to predict the heating deposition and leakage dose rates associated with a proposed large-beam TSR-II shield. (auth)

14546 (ORNL-TM-4611) FAST REACTOR EXPERIMENTAL SHIELDING PROGRESS REPORT FOR FEBRUARY 1974. 189a No. 10028, Activity No. HN 04 01 01 1. Clifford, C. E.; Muckenthaler, F. J.; Stevens, P. N. (Oak Ridge National Lab., Tenn. (USA)). Jun 1974. Contract W-7405-eng-26. 17p. AT.

The program to verify the accuracy of total cross sections was continued. Single-parameter hydrogen counter spectral measurements and BF_3 radial traverses were made for the bare beam with the beam collimated down to a 1-in. by 1-in. aperture. Single- and two-parameter hydrogen counter measurements were also made with ¼-in. Pb in the bare beam and with ¼-in. Pb plus 1-in. C in the beam. Some difficulties were encountered in the unfolding of the two-parameter data, and these results are not included. (auth)

14547 (RCN-206) TEMPERATURE AND HEAT FLUX DISTRIBUTION IN SODIUM COOLED FBR TYPE FUEL PINS WITH ECCENTRICALLY PLACED PELLETS. de Jong, H. D.; Vonka, V. (Stichting Reactor Centrum Nederland, Petten). Nov 1973. 31p. Dep. NTIS (US Sales Only) $4.75.

A theoretical study has been made to get an impression of the thermal behaviour of a typical LMFBR fuel pin, in which the pellets are placed eccentrically with respect to the cladding. The results are compared with those of electrically heated pins in use for the simulation of fuel pins in out-of-pile experiments. It turns out

that the expected eccentricity in LMFBR fuel pins influences the peripheral temperature and heat flux distributions to a larger extent than the eccentric assembly clearance of an accurately manufactured electrically heated pin. (auth)

14548 AXIAL NEUTRON STREAMING IN GAS-COOLED FAST REACTORS. Koehler, P.; Ligou, J. (Swiss Federal Inst. for Reactor Research, Wuerenlingen, Switzerland). Nucl. Sci. Eng.; 54: No. 3, 357-366(Jul 1974).

Calculations of neutron streaming in gas-cooled fast reactors (GCFR) designed with fuel pins have not been made properly up to now. The usual approach for computing the diffusion coefficients fails for two reasons: (a) the voided region is located at the cell boundary, and (b) the pitch is such that two-dimensional infinite gaps extend through the reactor. For an infinite lattice, the diffusion coefficient will diverge, which means that, in principle, the diffusion theory is no longer valid. This fact has been more or less forgotten because most theories assume cylindrical cells and therefore remove this difficulty artificially. Introducing the real size of the reactor at the beginning, a new theory of the streaming, which generalizes the usual approach, is developed; it appears as a buckling dependent term in the diffusion coefficient which diverges slowly for an infinite lattice. Fortunately, this term is small for usual reactor sizes, and one may, therefore, continue to use diffusion theory for practical calculations. The numerical applications to GCFR lattices show that the streaming was underestimated in the past. (auth)

14549 REACTIVITY ANOMALY DETECTION IN REAL TIME FOR A FAST REACTOR. De Lapparent, D. (CEA, Cadarache, France); Le Guillou, G.; Zwingelstein, G.; Besoux. pp 24.1-24.18 of Power Plant Dynamics, Control, and Testing. Knoxville, TN; Univ. of Tennessee (1973).

From an applications symposium on power plant dynamics, control and testing; Knoxville, Tennessee, USA (8 Oct 1973). See CONF-731021-.

The operation of Rapsodie since its start-up in 1967 has provided a good knowledge of the static and dynamic behavior of the reactor. The power reactivity coefficient has a strong influence on this dynamic behavior. A simple model of the reactor plant and of the power and temperature coefficients has been worked out; it is periodically checked-up through dynamic measurements during which reactivity steps are inserted. This model is to be used to detect behavior anomaly by comparing on line calculated and observed reactivity balances. The benefit of this work is to get a good reactivity control for the demonstration plant PHENIX 250 MW(e) which became critical on 31.8.73, and for the commercial plant SUPER-PHENIX 1200 MW(e) which is to start-up in 1980. 5 references. (auth)

14550 METHOD FOR THE IN-PILE MEASUREMENT OF THERMAL CONTACT CONDUCTANCES IN NUCLEAR-REACTOR FUEL RODS. van den Berg, M.; Schmidt, H. E. (EURATOM, Karlsruhe, Ger.). High Temp. - High Pressures; 5: No. 5, 589-596(1973).

Fuel-cladding thermal contact conductances in nuclear-reactor fuel pins can be determined during operation by measuring the phase shift of periodic temperature variations produced by radially-inward-flowing heat waves at the surface and in the center of the fuel rod. Solutions of the problem, i.e. the dependence of the gap conductance on phase shift, are given in graphical and numerical form for the typical geometry of a fast-breeder-reactor mixed-oxide fuel pin. Optimum periods for the temperature variations are of the order of seconds, while phase shifts would have to be measured with a resolution of 5 to 20 ms in order to obtain gap conductances with a precision of ±10%. (auth)

14551 START UP OF PHENIX. Guillemard, B. Nucl. Eng. Int.; 19: No. 216, 411-414(May 1974).

The Phenix commissioning tests and difficulties which were overcome during the operation are described. The start-up tests were divided into four phases; testing and making operational all plant general auxiliaries and circuits, filling of main sodium circuits and sodium testing, fuel loading to criticality and low power neutronic tests, and finally the first power operation. Full power was reached in March 1974. (UK)

14552 TESTING BOR-60-TYPE FUEL ELEMENTS IN THE SODIUM LOOP OF REACTOR MIR. Bibilashvili, Yu. K.; Golovnin, I. S.; Kalashnik, G. V.; Klochkov, E. P.; Kuz'min, V. I.; Lebedev, I. G.; Men'shikova, T. S.; Piskun, A. S.; Sytov, L. I.; Tsykanov, V. A. At. Energ. (USSR); 36: No. 5, 363-365(May 1974). (In Russian).

Twelve experimental fuel elements of a design identical to those of BOR-60 were irradiated in the sodium loop of the reactor MIR for parameters close to operational values. In the course of testing, the cladding temperature was 665°C and maximal heat load 485 W/cm. A 10% burnup of heavy atoms was achieved. Visual inspection with a magnification of 5 did not reveal any cladding failure. Two fuel elements, however, were leaky. The loss of tightness can be explained by the presence of microcracks in the cladding and welded joints. Gas activity was observed in the coolant circuit after 8.6% burnup of heavy atoms had been reached. Fission gas release from the fuel was in the range of ~ 70 to 90% of the theoretical value. It has been established that the strain accumulated in the cladding as a result of mechanical action of the swelling fuel core depends significantly on the initial density of the sintered fuel briquettes. Chemical interaction between fuel and cladding has not been observed. Post-irradiation investigations and calculations showed that most of the fuel elements had not yet exhausted their operational resources and were able to reach higher burnups. 5 references. (auth)

14553 PROPERTIES OF FISSION PRODUCTS FROM FAST FISSION OF ^{235}U, ^{238}U, AND ^{239}Pu. Pulz, E.; Krueger, F. W. (VEB Kombinat Kraftwerksanlagenbau, Berlin). Kernenergie; 17: No. 4, 109-114(Apr 1974). (In German).

The properties of the fission products formed in fast fission of ^{235}U, ^{238}U, and ^{239}Pu have been calculated. The results are, in particular, applied to estimation of the influence of operational parameters (fissionable material, generation time, cooling time, neutron flux) on the characteristic properties of fission products (chemical composition, production of shutdown heat, gamma-ray energy emission, gamma-ray spectrum). The parameters used are adequate to the conditions of fast power reactor operation. 24 references. (auth)

14554 FAST REACTORS. Orlov, V. V. At. Energ. (USSR); 36: No. 5, 341-355(May 1974). (In Russian).

An attempt is made to deal with fundamental problems of fast breeder reactor development. Questions of nuclear fuel reproduction, the physics and engineering of fast breeders, research and power reactors, and certain approaches to increasing the reproduction and economic competitiveness of fast reactors are considered. 19 references. (auth)

14555 COEFFICIENT OF REACTIVITY OF A FAST POWER REACTOR. Tinka, I. Jad. Energ.; 20: No. 3, 77-82(Mar 1974). (In Czech).

The possibilities in the use of a program written on the basis of the perturbation theory for the calculation of the reactivity coefficient of the reactor were illustrated on the example of the fast power reactor of the BN-350 type. The sodium reactivity coefficent and, by the use of a simple computational model, the temperature coefficient and the power factor were also considered. Some results of the calculation of the Doppler coefficient were reported. 9 references. (tr-auth)

14556 SODIUM SYSTEMS OF THE SNR-300. Brandstetter, A.; Dreyer, S. (International Atomreaktorbau GmbH (INTERATOM), Bensberg, Ger.). Kerntechnik; 16: No. 3, 115-120(Mar 1974). (In English and German).

The heat transfer system of the SNR-300 comprises three parallel loops, with each containing a primary loop with radioactive sodium and a secondary loop with non-radioactive sodium. The main characteristics of the system are determined by the properties of sodium and after-heat removal requirements. A separate emergency cooling system is also provided. The main loops are connected to auxiliary systems for purifying, draining, collecting leakage, maintaining primary system coolant level, and relieving pressure in the secondary system. Cover gas systems are also provided. (GE)

14557 STATUS OF FUEL ELEMENT DEVELOPMENT FOR FAST REACTORS. Karsten, G. G. (Kernforschungszentrum, Karlsruhe, Ger.). Kerntechnik; 16: No. 3, 126-129(Mar 1974).

The development of fuel elements for the SNR-300 can be characterized as being in a status of transition from basic research to technological realization. The next step will be the formulation of the specifications for the first load of fuel elements. The main areas of research and the results of the past years are described. Fuel, cladding, pins and the complete fuel element will be the subjects of discussion. However, it will be necessary to reflect also upon the strategy of the development under aspects of the requirements for fuel elements of commercial breeder reactors of the generation which follows the demonstration plants. (GE)

Research, Test, and Experimental Reactors

Refer also to abstracts 14535, 14545, 14589, and 14590.

14558 (ANL-7836) TEN YEARS OF OPERATING EXPERIENCE WITH MECHANICAL COMPONENTS OF THE EBR-II

FUEL-HANDLING SYSTEM (1963–1972). Cerutti, B. C.; Waldo, J. B. (Argonne National Lab., Ill. (USA)). Dec 1973. Contract W-31-109-eng-38. 95p. AT.

Experimental Breeder Reactor II (EBR-II) is an unmoderated, sodium-cooled reactor with a design power level of 62.5 MW(t). The design uses a submerged, pool concept, the reactor and fuel-handling components being contained in a primary tank filled with sodium. Performance of the fuel-handling system has been very good, considering its extensive usage, the experimental nature of the equipment, and the hostile environment in which it must operate. Preoperational checkout of the system revealed the need for modification and improvement of some components. Continuing engineering surveillance directed toward resolution of operational difficulties has resulted in additional redesign or modification of components to upgrade system performance and reliability. Experience with the EBR-II fuel-handling components has shown that accessibility and maintainability are important considerations that should be formulated as components are designed. Space at a reactor facility should be provided, if possible, for assembly areas, sodium-cleanup facilities, and shielded repair areas for maintenance on radioactive components. As of July 31, 1972, operating experience with the EBR-II fuel-handling system consisted of 6277 unrestricted, 3373 restricted, and 1462 special subassembly transfers. The design of the EBR-II fuel-handling components and the associated operating experience are applicable, to a large extent, to the design of future large fast reactors. (auth)

14559 (BNL-18509) HIGH FLUX BEAM REACTOR TECHNICAL SPECIFICATIONS. (Brookhaven National Lab., Upton, N. Y. (USA)). Dec 1973. 85p. Dep. NTIS $7.25.

Technical specifications were established in compliance with AEC requirements and guides. The specifications define the boundaries for safe operation of the reactor and should not be interpreted as a guide for routine operation. Rules, procedures and limits provided for the daily operation of the reactor are generally more restrictive than the technical specifications. (auth)

14560 (IKE-6-76) REACTIVITY INFLUENCE OF MOVABLE REFLECTOR SEGMENTS IN THE CRITICAL EXPERIMENT ITR. Bernnat, W. (Stuttgart Univ. (TH) (F. R. Germany). Inst. fuer Kernenergetik). Dec 1973. 28p. (In German). INIS.

The critical assembly ITR at Juelich is a compact facility with a rather complicated geometry. The theoretical determination of reactivity and other kinetic parameters is possible only with 3D transport codes, for example Monte Carlo calculations. Such a code suitable to calculate perturbations due to changes in geometry is described. It is used to calculate two shutdown experiments, the removal of a 2 cm thick reflector from CORE IIa/2 and the positioning of a swingable segment in CORE VI. The results are compared with inverse kinetics measurements. (GE)

14561 (INIS-mf-1118) GENERAL OUTLINE OF THE OPERATION AND UTILIZATION OF THE BR2 REACTOR. Baugnet, J. M.; Leonard, F.; Vanhaelewijn, R.; Bobin, K. J.; Gandolfo, J. M.; Lenders, H. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium); Commission of the European Communities, Brussels (Belgium)). 1973. 42p. INIS.

From symposium on the results of five years of BR2 reactor utilization; Mol, Belgium (4 Dec 1973).

The reactor has operated at power levels ranging from 58 to 88 MW. The highest value of thermal neutron flux attained is 9×10^{14} $n.cm^{-2}.s^{-1}$, and the fast neutron flux ($E > 0.1$ MeV) reached a level of 6×10^{14} $n.cm^{-2}.s^{-1}$. The experimental load increased considerably between 1969 and 1973, the rise being reflected by an average occupation of 76 channels at the end of the period compared with 45 in 1968. The reactor has been used for development programs concerning fast reactors, gas-cooled reactors, light water reactors and homogeneous reactors, as well as for applied research on fissile materials, structural materials and nuclear transmutations, for radioisotopes production, for pilot scale gamma irradiations and for basic research in nuclear and solid state physics. (auth)

14562 (INIS-mf-1126) LOOP IRRADIATION EXPERIMENTS MOL-7A AND MOL-7B. Kummerer, K. (Kernforschungszentrum Karlsruhe (F.R. Germany). Inst. fuer Material- und Festkoerperforschung). 1973. 16p. INIS.

From symposium on the results of five years of BR2 reactor utilization; Mol, Belgium (4 Dec 1973).

The objective of the Mol-7A experiment was to irradiate a bundle with mixed oxide pins designed similar to fast reactor fuel pins (including fuel zone, axial blanket and fission gas plenum) under Na cooling in a flux with a large high neutron energy component; to get a maximum rod power of 500 watts/cm, a maximum clad temperature of 630°C and a target burnup of 60000 MWd/t M; to investigate the external and internal pin geometry after irradiation (diameter increase, fuel structure etc.) and to evaluate fission gas release, fission product distribution and internal attack to the 3 different stainless steel cladding materials. (INIS)

14563 (KFK-1894) INVESTIGATION OF THE INFLUENCE OF SPACERS ON THE FLOW-INDUCED VIBRATIONS OF FUEL PLATES OF THE GRENOBLE HIGH FLUX REACTOR. De Grande, A.; Kadlec, J. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Reaktorentwicklung). Dec 1973. 52p. (In German). Dep. NTIS (US Sales Only) $5.75.

An experimental investigation of the parallel flow-induced vibrations of fuel plates for two technological variants of the fuel assembly is described. The influence of spacers on the natural frequencies and on corresponding normal modes of one fuel plate was investigated on experimental equipment with electromagnetic excitation of vibrations. Investigations were carried out on the influence of spacers on the flow induced vibrations of the fuel plates, using the segment of the fuel assembly with fourteen plates. A detailed description is presented of the experimental facilities used, and the results of the experiments are indicated and discussed. (auth)

14564 (LMEC-74-6) CHEMICAL AND PHYSICAL TESTING OF THERMAL INSULATION MATERIALS FOR USE AT FFTF AND SPTF. Balkwill, J. K. (Liquid Metal Engineering Center, Canoga Park, Calif. (USA)). 1 Apr 1974. Contract AT(04-3)-700. 225p. AT.

Chemical and physical testing of 26 thermal insulation materials was performed to qualify selected materials for further evaluation and possible use at the Fast Flux Test Facility and the Sodium Pump Test Facility. All materials tested showed satisfactory compatibility with 1050°F sodium in air; the sodium tended to burn out on the surface of the denser materials, and penetrated into the felt-type materials. The thermal insulation materials judged acceptable according to the chemical analysis requirements governing chloride and inhibitor content totaled 19, 13 of which passed the stress corrosion cracking test. The 13 materials that met all chemical test requirements included calcium silicate and refractory fiber felted types, both suitable for rigid thermal insulation; loose wool and blanket types, suitable for free-form thermal insulation; structural board types, suitable for components such as pipe supports where high strength is needed; and extra-low-conductivity types. One calcium silicate material and one felted type successfully passed a 24-hr 1500°F heater contact test. Compression testing of 4 materials under a 1000°F thermal gradient showed the structural board type, Marimet-45, to have superior strength to the calcium silicate types. Exposure before compression testing to various vibration loadings under a thermal gradient did not seriously alter the load-bearing capabilities of the materials. Subsequent room-temperature compression testing to failure of the structural board types confirmed that Marimet-45 was the strongest material in the test program. Vibration loadings of earthquake magnitude did not alter the compressive properties of the material. (auth)

14565 (N-74-10629) ANALYZING THE THERMIONIC REACTOR CRITICAL EXPERIMENTS. Niederauer, G. F. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). Nov 1973. 45p. (NASA-TM-X-2925). NTIS $3.00.

The Thermionic Reactor Critical Experiments (TRCE) consisted of fast spectrum highly enriched ^{235}U cores reflected by different thicknesses of beryllium or beryllium oxide with a transition zone of stainless steel between the core and reflector. The mixed fast-thermal spectrum at the core reflector interface region poses a difficult neutron transport calculation. Calculations of TRCE using ENDF/B fast spectrum data and GATHER library thermal spectrum data agreed within about 1 percent for the multiplication factor and within 6 to 8 percent for the power peaks. Use of GAM library fast spectrum data yielded larger deviations. The results were obtained from DOT R Theta calculations with leakage cross sections, by region and by group, extracted from DOT RZ calculations. Delineation of the power peaks required extraordinarily fine mesh size at the core reflector interface. (auth)

14566 ANISOTROPIC NEUTRON DIFFUSION IN LATTICES OF THE ZERO-POWER PLUTONIUM REACTOR EXPERIMENTS. Gelbard, E. M. (Argonne National Lab., IL). Nucl. Sci. Eng.; 54: No. 3, 327-340(Jul 1974).

Diffusion coefficients are computed for a typical lattice cell of the zero-power plutonium reactor experiments using the methods of Benoist and Bonalumi. It is noted that the diffusion coefficients, D_x, for leakage normal to the plates, as defined by Benoist and by Bonalumi, are both double valued. The spread between Benoist's x-diffusion coefficient is, in the lattice cell, over half as large as the difference between D_x and D_y. Bonalumi's x-diffusion coefficients are much farther apart, the interval between them being

considerably larger than the difference between D_x and D_y. Neither the Benoist nor the Bonalumi method yields homogenized diffusion coefficients that preserve fluxes, reaction rates, or eigenvalues. Using an approach similar to that of Deniz, the diffusion coefficient is redefined and constructed in such a way as to guarantee that eigenvalues will be preserved in the homogenization process. The relation between the new diffusion coefficients and the Benoist coefficients is discussed. (auth)

14567 FAST SUBSTITUTION LATTICE IN THE ROSSENDORF ANNULAR CORE REACTOR (RRR). Faehrmann, K.; Huettel, G.; Krause, H. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie; 17: No. 3, 70-73(Mar 1974). (In German).

For conducting reactor-physical studies in the field of fast neutrons a fast substitution lattice for the thermal annular core reactor RRR was conceived. The construction of the fast-slowly coupled system and its applications are briefly discussed. The start-up measurements on three selected lattice configurations carried out with special respect to the safety aspect are compared with theoretical data. 6 references. (auth)

14568 DESIGN AND MANUFACTURE OF SODIUM FILLED CALANDRIA FOR USE IN ZERO-POWER FAST REACTORS. Hilton, R. K. (United Kingdom Atomic Energy Authority, London). Nucl. Eng. Int.; 19: No. 216, 401-405(May 1974).

A program of basic work, which compared the nuclear properties of pin and plate-type fuel geometries, was carried out in the Zebra reactor. The program required pin-type fuel to be housed in a sodium-filled calandria of approximately 2 in. sq. section. This led to assemblies of differing shapes, size and numbers. These were used in support of the PNC-Mozart and U. K. fast reactor programs. Descriptions are given of the design and manufacture of the calandria, welding machines, sodium filling equipment, testing, and production experience. (UK)

14569 STUDY OF THE MISSOURI UNIVERSITY RESEARCH REACTOR TEMPERATURE FEEDBACK KINETICS. Gist, W. J. Columbia, MO; University of Missouri (1973). 155p. University Microfilms Order No. 74-9935.

Thesis (Ph. D.).

A model for the Missouri University Research Reactor was developed. This model consisted of a set of differential equations which describe the reactor neutron kinetics and temperature feedback kinetics. These equations were put in state variable form and the frequency response was calculated at various reactor power levels. The modified Mikhailov method was used to determine the stability of the model. Tests were devised to find the experimental frequency response of the Missouri University Research Reactor. The step test method and the multifrequency binary sequence frequency response test method were used to obtain the reactor's frequency response. These tests were conducted at 1.0, 2.5, and 4.0 megawatts. The experimental results were compared with the frequency response of the model at the corresponding power levels. Certain model parameters were then adjusted so that model predictions more closely fit the experimental results. (Diss. Abstr. Int., B)

Production and Materials Testing and Processing Reactors

Refer also to abstracts 14525, 14540, 14561, 14562, 14637, and 14649.

14570 (INIS-mf-1129) IRRADIATION OF ADVANCED FUELS IN THE FRAME OF THE FAST BREEDER PROJECT. Van Lierde, W. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). 1973. 9p. INIS.

From symposium on the results of five years of BR2 reactor utilization; Mol, Belgium (4 Dec 1973).

A survey of the Belgian irradiation programme on carbide and carbonitride fast fuels in BR2 is presented. It contains irradiation experiments in the hydraulic conveyor, in Pom-type devices, in the Circe rig and in a MERS type integrated sodium loop. (auth)

14571 (INIS-mf-1130) POM IRRADIATION OF THE EUROPEAN INSTITUTE FOR TRANSURANIUM ELEMENTS, PERIOD 1969-1973. Campana, M.; Gabolde, J. (Commission of the European Communities, Karlsruhe (F. R. Germany). European Inst. for Transuranium Elements). 1973. 10p. INIS.

From symposium on the results of five years of BR2 reactor utilization; Mol, Belgium (4 Dec 1973).

The POM irradiation device was developed at the Transuranium Institute in 1965-1966 with the aid of the Technology Department of the Groupe d'Exploitation BR2. Specifications and operating characteristics are presented. (INIS)

14572 (ORNL-TM-4616) HIGH FLUX ISOTOPE REACTOR QUARTERLY REPORT, JANUARY-MARCH 1974. McCord, R. V.; Corbett, B. L. (Oak Ridge National Lab., Tenn. (USA)). Jun 1974. Contract W-7405-eng-26. 24p. Dep. NTIS $4.25.

A three-week shutdown to evaluate the extent and consequences of cracks found in the permanent beryllium assembly resulted in a reactor on-stream time of only 71.5% this quarter. It was concluded that continued reactor operation with the damaged beryllium would not result in any significant decrease of the reactor safety margins. The semiannual reactor component inspection and replacement was completed this quarter, and the control plates were changed. (auth)

14573 TWO-DIMENSIONAL TRANSPORT CALCULATIONS FOR THE DETERMINATION OF BURNUP-DEPENDENT MICRO FLUX DENSITY DISTRIBUTIONS IN MTR FUEL ELEMENTS. Krueger, A.; Mueller, A. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht, Ger.). Atomkernenergie; 19: No. 4, 333-334(1972). (In German). (GKSS-72-E-16-(P.2)).

Propulsion and Package Reactors

Refer also to abstracts 13083 and 13084.

14574 (GKSS-72-E-3) NS "OTTO HAHN." Test Report No. 17. Cargo and Research Travels (Tripe No. 58-64) within the Time from June 5 to October 11, 1971 to Buenos Aires, Bahia Blance, Rotterdam, Nouadhibou, Sfax and Casablanca. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Hamburg (F.R. Germany)). 1972. 34p. (In German).

14575 (N-74-16372) DIGITAL COMPUTER STUDY OF NUCLEAR REACTOR THERMAL TRANSIENTS DURING STARTUP OF 60-kWe BRAYTON POWER CONVERSION SYSTEM. Jefferies, K. S.; Tew, R. C. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). Feb 1974. 21p. (NASA-TM-X-2984). NTIS $2.75.

A digital computer study was made of reactor thermal transients during startup of the Brayton power conversion loop of a 60-kW(e) reactor Brayton power system. A startup procedure requiring the least Brayton system complication was tried first; this procedure caused violations of design limits on key reactor variables. Several modifications of this procedure were then found which caused no design limit violations. These modifications involved: using a slower rate of increase in gas flow; increasing the initial reactor power level to make the reactor respond faster; and appropriate reactor control drum manipulation during the startup transient. (auth)

14576 STUDIENGESELLSCHAFT ZUR FOERDERUNG DER KERNENERGIEVERWERTUNG IN SCHIFFBAU AND SCHIFFAHRT eV., HAMBURG, INFORMATIONEN, NR. 23, DEZEMBER 1973. (Association for Research on Nuclear Energy Utilization in Ship Construction and Propulsion, Hamburg, Notices, No. 23, Dec. 1973). Hamburg; Studiegesellschaft zur Foerderung der Kernenergieverwertung in Schiffbau und Schiffahrt eV (1973). 17p. (In German).

The opening of the international bureau of the GKSS is announced. The start-up of the sea water loop (MEWAK I) and recent developments on membrane filters are discussed. Nuclear parameters and the economics of nuclear ships are tabulated. New guidelines are announced by the German Lloyds on the classification and construction of ocean vessels with nuclear installations. (JSR)

14577 THERMAL AND REACTOR ANALYSIS OF NUCLEAR ROCKET TRANSIENTS. Mills, R. R. Jr. Raleigh, NC; North Carolina State University (1973). 215p. University Microfilms Order No. 74-5498.

Thesis (Ph. D.).

The thermal and nucleonic behavior of a nuclear rocket during the startup transient was investigated. The fluid flow and heat transfer of the hydrogen coolant was thoroughly analyzed. It was found that the ideal gas law produced reasonably accurate results over the range of temperatures and pressures used in this study. A one-dimensional time-independent form of the three-dimensional time-dependent fluid flow equations was developed and shown to be suitable for calculations over a very wide range of fluid temperature and pressure. An expression for heat transfer in the fuel-moderator was derived which simplified time-dependent calculations of average fuel temperature distributions and wall temperature distributions. A three-group model of the reactor physics provided a good understanding of the neutronics of a NERVA reactor. Perturbation theory was shown to be applicable during the startup transient. The perturbation theory expression

that was developed for the hydrogen reactivity correctly predicts the linear variation of reactivities with low values of hydrogen density and the departure from linear variation at high values of density. (Diss. Abstr. Int., B)

14578 CONVERSION OF PARA TO ORTHOHYDROGEN IN NUCLEAR ROCKET RADIATION FIELDS. Robinson, C. P.; Bartlit, J. R.; Stokes, R. W.; Conant, J. W.; Edeskuty, F. J. (Los Alamos Scientific Lab., NM). pp 577-580 of Progress in Refrigeration Science and Technology. Vol. 1. Westport, CT; AVI Publishing Co. (1973).

Measurements to determine the orthohydrogen concentration in the propellant stream of two Nerva type reactors are reported. The measurement technique was similar in both experiments. The results presented in tabular form are given as a function of reactor power. The potential mechanisms by which radiation can convert parahydrogen to orthohydrogen are discussed. (IAA)

Reactor Safety and Environmental Aspects

Refer also to abstracts 12701, 12912, 13014, 13290, 14509, 14525, 14543, 14683, and 14684.

14579 (AED-CONF-73-500-2) CARRYING-OUT OF REALISTIC CALCULATIONS AS A BASIS FOR THE DESIGN OF EMERGENCY COOLING SYSTEMS. Karwat, H. (Technische Univ. Muenchen, Garching (F.R. Germany). Lab. fuer Reaktorregelung und Anlagensicherung). 1973. 15p. (In German). INIS.

Within the licensing procedure analytical investigations with respect to emergency core cooling are of ultimate importance. The conclusions drawn from the result of these investigations are essential to find a judgement on the expected efficiency of the emergency core cooling systems with respect to the thermal power of the reactor before a loss-of-coolant accident occurs. The result of analytical investigations influencing the technical design of ECC-systems are discussed. Considering the requirements which the ECCS has to meet, it is concluded, that the analysis is a good and necessary test for the design of the systems. The importance of the reliability analysis which also takes into consideration the energy supply, the instrumentation and control of the systems is frequently mentioned. (INIS)

14580 (AED-CONF-73-500-3) METHODICAL POSSIBILITIES OF RELIABILITY ANALYSIS FOR THE EVALUATION OF EMERGENCY COOLING SYSTEMS. Heuser, F. W. (Institut fuer Reaktorsicherheit der Technischen Ueberwachungs-Vereine e.V., Koeln (F.R. Germany)). 1973. 20p. (In German). INIS.

A reliability analysis is given for a simple model system of an emergency core cooling system of a pressurized water reactor. Special attention is given to some main principles of the reliability analysis methods and their application for evaluating system's safety description in quantitative terms. Referring to the results, the failure behavior of the emergency core cooling system is discussed in connection with the influence of repair procedures, inspection strategies and failures of subsystems. The concepts for estimating some maximal repair duration times that are allowed for the emergency core cooling system during standby are described. (auth)

14581 (AED-CONF-73-500-4) STATEMENTS OF APPLIED RELIABILITY ANALYSIS. Balfanz, H. P. (Institut fuer Reaktorsicherheit der Technischen Ueberwachungs-Vereine e.V., Koeln (F.R. Germany)). 1973. 24p. (In German). INIS.

A general review of the procedures and possibilities of reliability analysis in the evaluation of ECCS is given. The ECCS for a PWR has been chosen as a reference system because the IRS has gained most experience with that. In principle, however, the statements of the reliability analysis presented here are valid for all other types of ECCS. Up to now, the methods which have been employed in the investigation of systems reliability in licensing procedures in the FRC are those of Fault Tree Analysis, which are discussed. The choice of the "undesired event" is discussed. System failure criteria are developed from emergency core cooling efficiency data. The construction of the Fault Tree is illustrated by examples of different emergency core cooling components, and results are given of the reliability computation. The limits of reliability analysis as a tool in evaluating systems are discussed. (INIS)

14582 (AEEW-R-905) SABRE CODE FOR PREDICTION OF COOLANT FLOWS AND TEMPERATURES IN PIN BUNDLES CONTAINING BLOCKAGES. Gosman, A. D.; Herbert, R.; Patankar, S. V.; Potter, R.; Spalding, D. B. (UKAEA Reactor Group, Winfrith. Atomic Energy Establishment). Oct 1973. 18p. (CONF-731020-2). Dep. NTIS (US Sales Only) $4.00.

From international heat transfer meeting; Karlsruhe, F. R. Germany (9 Oct 1973).

The possibility of blockages occurring in the rather tightly packed bundles of an LMFBR is now widely studied since it is a possible way of causing sodium boiling and expulsion. A new code called SABRE (for Subchannel Analysis of Blockage in Reactor Elements) has been developed for Winfrith by Imperial College. SABRE is based on the method of solution given by Caretto et al., and works on a computational framework in which the control volumes are lengths of the sub-channels between adjacent pins or pins and boundaries. The conservation of mass, momentum and energy for each control volume provides a set of simultaneous equations, with provision for convection and turbulent diffusion, which can be solved iteratively when appropriate boundary conditions are specified. These can include total or porous blockages at any point in the cluster. The code then yields predictions of the three-dimensional fields of axial and lateral velocities, pressure and temperature within the cluster. Application of SABRE to a wide range of experimental and reactor situations is in progress. Results already available demonstrate the capability of calculating upstream effects and reverse flow in wake regions. The size of blockage to produce boiling is under investigation. Comparisons with experimental results for a simulated blockage in a water rig are given to illustrate the capability of the program. (UK)

14583 (ANCR-1148) EXPERIMENT DATA REPORT FOR 1½-LOOP SEMISCALE SYSTEM ISOTHERMAL TESTS 1001, 1002, AND 1003. Alder, R. S.; Feldman, E. M.; Olson, D. J.; Pinson, P. A. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA)). May 1974. Contract AT(10-1)-1375. 110p. Dep. NTIS $5.45.

Recorded test data are presented for Tests 1001, 1002, and 1003 of the isothermal portion of the Semiscale Blowdown and Emergency Core Cooling (ECC) Project. Although the major emphasis in the isothermal blowdown experiments was on ECC delivery, the tests were conducted without injection of simulated ECC in order to establish the baseline system behavior and to determine the effects of lower plenum geometry and heat transfer characteristics. The data, presented in the form of composite graphs in engineering units, have been analyzed only to the extent necessary to assure that they are reasonable and correct. The intent is to make available the uninterpreted data from Tests 1001, 1002, and 1003 for use by others and for support of subsequent interpretative reports and analyses. (auth)

14584 (BNL-18921) AXIAL POWER PEAKING FACTORS FOR POINT BEACH 2. Lellouche, G. S. (Brookhaven National Lab., Upton, N. Y. (USA)). May 1974. 14p. Dep. NTIS $4.00.

A series of NØAH calculations whose purpose is to check the accuracy of Westinghouse predictions of some "load-following" transients is discussed. Generally, agreement with the Westinghouse results is quite good, with the methods comparing within ±2% in peaking factor. This degree of accuracy is, however, sufficient to find cases which just cross the fly speck lines, thus indicating that the lines are very closely drawn and leave little leeway. Results indicate that the proposed operational scheme for load following for the 3800/4100 RESAR-41 cores allows the flux difference to exceed the technical specifications. (auth)

14585 (CEC-380-73) RADIOACTIVE EFFLUENTS FROM NUCLEAR POWER STATIONS IN THE COMMUNITY. Discharge Data Radiological Aspects. (Commission of the European Communities, Luxembourg. Directorate for Health and Safety). Nov 1972. 46p. INIS.

Data are assembled for 1969, 1970, 1971 on radioactive waste discharges from the nuclear power stations in the European Community. In the case of gaseous effluents a distinction is drawn between noble gases, aerosols and iodine-131, and in the case of liquid effluents between the total activity (excluding tritium) and tritium alone. The discharge data are compared with the discharge limits for the various power stations. In addition, for the liquid effluents the average yearly concentrations reached in the receiving waterbodies are shown, expressed as a percentage of the maximum permissible concentration in drinking water. Based on the actual waste releases, an evaluation is made of the maximum exposure around each plant site and this exposure is compared with the radiological protection standards in force and with the natural radiation background. For each power station the ratio of activity discharged to energy produced is given. (INIS)

14586 (CONF-740537-1) DEVELOPMENT OF THE DELAYED-NEUTRON TRIANGULATION TECHNIQUE FOR LOCATING FAILED FUEL IN LMFBR. Kryter, R. C. (Oak Ridge National Lab., Tenn. (USA)). [nd]. 24p. Dep. NTIS $4.25.

From meeting on in-core instrumentation and failed-fuel detection and location; Toronto, Canada (13 May 1974).

One technique being considered for the location of failed fuel in

an operating reactor is a triangulation method in which the relative strengths and arrival times of signals from delayed-neutron monitors positioned on each of the reactor's coolant outlet pipes are intercompared (and corrected, if necessary, with experimentally derived calibration data) in such a way as to indicate the location of a subassembly containing a defective fuel pin. For about 3 years ORNL has carried on a small development study of the delayed-neutron triangulation (DNT) method in support of both the Fast Flux Test Facility (FFTF) and the follow-on Clinch River Breeder Reactor (CRBR). Two major accomplishments of the ORNL DNT program are (1) an analysis of anticipated detector counting rates and sensitivities to unclad fuel and erosion types of pin failure, and (2) an experimental assessment of the accuracy with which the position of failed fuel can be determined in the FFTF (this was performed in a quarter-scale water mock-up of realistic outlet plenum geometry using electrolyte injections and conductivity cells to simulate delayed-neutron precursor releases and detections, respectively). The major results and conclusions from these studies are presented, along with plans for further DNT development work at ORNL for the FFTF and CRBR. (auth)

14587 (EUR-5057) 50 MWe DODEWAARD NUCLEAR POWER PLANT. Annual Report, 1972. (Gemeenschappelijke Kernenergiecentrale Nederland N. V., Dodewaard; Samenwerkende Electriciteits-Productiebedrijven N. V., Arnhem (Netherlands)). Apr 1974. 146p. (In Dutch). Dep. NTIS (US Sales Only) $10.50. EUR BF 185,-.

A survey of plant operation deals with repairs to faulty safe ends of nozzles on the reactor pressure vessel and with the attendant investigations into reactor safety. These faults gave rise to a great deal of publicity which was stirred up by inaccurate press reports. The loss of output resulting from these faults was equivalent to 47 days' outage. (auth)

14588 (EURFNR-1171) IDENTIFICATION OF THE LMFBR DYNAMIC STATE FOR DETECTION OF COOLANT BOILING. Wiberg, D. M. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Angewandte Systemtechnik und Reaktorphysik). Feb 1974. 52p. (KFK-1911). Dep. NTIS (US Sales Only) $5.75.

Work performed under United States–Euratom fast reactor exchange program.

Modern identification theory is applied to equations describing an LMFBR to investigate the feasibility of estimating spatial sodium coolant and fuel pin temperatures. It is shown that measurement errors can be reduced and unmeasurable states estimated by a Kalman filter. These state estimates can then be used in conjunction with other indications of sodium boiling to form a scram criterion. Furthermore, the state estimates can be used by the reactor operators to assess reactor safety under many conditions. The need is shown for further study of off-line tuning of the Kalman filter to estimate spatial fuel burnup distribution and to estimate contaminant accumulation in a subassembly. (auth)

14589 (HEDL-TME-73-6(Vol. 2)) HEDL QUARTERLY TECHNICAL REPORT, OCTOBER–DECEMBER 1973. Volume II. Reactor and Safety Engineering. Grace, J. N. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Jan 1974. Contract AT(45-1)-2170. 70p. AT.

Information is presented concerning FFTF kinetics, nuclear data, core physics, and safety analysis of hypothetical core disruptive accident. (DCC)

14590 (HEDL-TME-74-1(Vol. 2)) HEDL QUARTERLY TECHNICAL REPORT, JANUARY–MARCH 1974. Volume II. Reactor and Safety Engineering. Siember, R. J. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Apr 1974. Contract AT(45-1)-2170. 79p. AT.

Information is presented concerning FFTF energy systems analysis, core physics, and safety analysis of hypothetical core disruptive accident. (DCC)

14591 (INIS-mf-1215, pp H2-24) QUANTITATIVE COMPARISON OF SITING POLICIES FOR NUCLEAR REACTORS AND ASSESSMENT OF HAZARDS DUE TO ADDITIONAL POPULATION AT PROPOSED REACTOR SITES IN ISRAEL. Tadmor, J.; Striem, H. L. (Israel Atomic Energy Commission, Yavne). 1973.

From 4th scientific conference of the Israel Ecological Society; Tel Aviv, Israel (8 Apr 1973).

The rapid industrial development of Israel and the increase in its population impel a re-examination of its reactor siting policy, hitherto based on defined exclusion and low population areas. After a brief review of the siting policies and practices of various countries, a quantitative comparison of site hazards is made on the basis of three ratings: a proposed "Weighted Index of Site Hazards" (WISH), based on the product of the pollutant source strength (thermal power of the reactor), the populations enclosed within successive annular zones and a distance weighting factor expressing the effect of the pollutant at this distance; a "Weighted Sectorial Hazards Index", based on the product of each population, its distance weighting factor and the wind frequency within each sector; and the "Weighted Population Radiation Dose", based on the product of the radiation doses caused within a given sector and the wind frequency for this sector. The three ratings are also used to evaluate the increase in the site hazard when additional population is admitted into the vicinity of a proposed reactor in Israel. The WISH index is easily calculated and was found to give fair approximations to relative site ratings, obtained by much more laborious other methods. The proposed site rating methods may also be used for comparison of sites of other pollution emitting plants. (INIS)

14592 (INIS-mf-1323) TRANSIENT BEHAVIOUR OF NUCLEAR STEAM GENERATORS. Ten Wolde, D. G. (Technische Hogeschool Delft (Netherlands)). 5 Jul 1972. 187p. INIS.

For the purpose of both safety assessment and control system design of nuclear power plants a thorough knowledge is required of the transient behavior of the total plant and thereby of each individual component. Various aspects of the simulation of the nonlinear transient thermal behavior of steam generators are discussed. Both the evaporator in a sodium-cooled fast breeder reactor power plant (LMFBR) and the steam generator in a pressurized water-cooled thermal reactor power plant (PWR) are dealt with. The one-dimensional balance equations for single-phase and two-phase flow are derived. A computer code WIGWAM is presented, which simulates the dynamic behavior of cylindrical walls. The code is used for investigating the necessity for including a dynamic tube wall model in the transient analysis of the above-mentioned steam generator types. The simulation of a once-through sodium-heated evaporator of the design proposed for the 300-MW prototype SNR power plant is given. The following subjects are discussed: the reduction of the steam generator to a single characteristic tube, the selection of the heat transfer correlations, the hybrid CSDT approach, and various results obtained with the distributed parameter model SHOT. Also, an analysis is presented of the problems which may arise if a lumped parameter approach is applied. Experimental results obtained on a 6-MW PWR steam generator model and experimental verification of both the hybrid CSDT distributed parameter model PURE and the lumped parameter model DIMOS. The studies are intended to provide qualitative and quantitative information for the optimization of transient simulations of heat exchangers with respect to accuracy and computing time. (INIS)

14593 (MRR-113) PROBLEMS OF HEAT TRANSFER IN A REACTOR CORE DURING FAST PRESSURE AND MASS FLOW TRANSIENTS. Liesch, K. J. (Technische Univ. Muenchen, Garching (F.R. Germany). Lab. fuer Reaktorregelung und Anlagensicherung). Jun 1972. 27p. (In German). INIS.

Calculation problems of heat transfer coefficients during the early phase of the depressurization of a pressurized water reactor initiated by a loss-of-coolant accident are discussed. The special thermohydraulic processes within the core region make the calculation more difficult and inaccurate. An attempt to introduce steady-state heat transfer correlations was made. (GE)

14594 (ORNL-4968) PLANNING GUIDE FOR HTGR SAFETY AND SAFETY-RELATED RESEARCH AND DEVELOPMENT. (Oak Ridge National Lab., Tenn. (USA)). May 1974. Contract W-7405-eng-26. 475p. Dep. NTIS $10.60.

The safety characteristics and safety margins under postulated accident conditions for high-temperature gas-cooled reactors (HTGRs) being built and planned in the United States are discussed. Both safety and safety-related work that could be done to further refine the technology are identified. The work is divided into seven task areas: (1) all aspects of systems and safety analysis; (2) fission-product technology; (3) primary coolant technology; (4) seismic and vibration technology; (5) confinement components (concrete reactor vessel and containment structures); (6) materials technology; and (7) safety instrumentation. (auth)

14595 (RDT-C-14-1-T(4-74)) VENTILATION EXHAUST RADIATION MONITORING SYSTEM. (USAEC Division of Reactor Research and Development, Washington, D. C.). Apr 1974. 29p. RSO.

Requirements are established for design, fabrication, test, calibration, quality assurance, and preparation for delivery of both ventilation exhaust radiation monitoring systems that are part of plant protection systems for nuclear reactor facilities and for other applications where less stringent requirements pertain. (auth)

14596 (RDT-C-14-2-T(4-74)) AREA RADIATION MONITORING SYSTEM. (USAEC Division of Reactor Research and Development, Washington, D. C.). Apr 1974. 26p. RSO.

Requirements are established for design, fabrication, test, calibration, quality assurance, and preparation for delivery of both

area radiation monitoring systems that are part of plant protection systems for nuclear reactor facilities and for other applications where less stringent requirements pertain. (auth)

14597 (RDT-E-4-6-T(5-74)) INTERMEDIATE HEAT EXCHANGER FOR LIQUID METAL SYSTEMS. (USAEC Division of Reactor Research and Development, Washington, D. C.). May 1974. 36p. RSO.

Requirements are delineated for liquid metal-to-liquid metal heat exchangers constructed in accordance with code requirements and special requirements that are additive or more restrictive. The requirements apply to shell-and-tube "intermediate" heat exchangers used to transfer heat between the primary and secondary liquid metal coolants of reactor heat transport systems. (auth)

14598 (RDT-F-2-9-T(6-74)) RELIABILITY ASSURANCE. (USAEC Division of Reactor Research Development, Washington, D. C.). Jun 1974. 19p. RSO.

Reliability and maintainability requirements, design techniques and verification methods, including analysis, review, testing, and data collection and feedback, are established. The requirements set forth are applicable primarily to projects which involve design, development, and modification of nuclear facilities, including advanced research and test reactors and nuclear power plants, and evaluation of reliability and maintainability data for these other nuclear and non-nuclear facilities, such as fuel reprocessing plants and test facilities. The requirements apply to those systems and components whose satisfactory performance is required for startup; operation, shutdown, and refueling of the facility as well as to those which provide for the prevention of accidents and mitigation of consequences of accidents. (auth)

14599 (SRD-R-27) ANALYSIS OF PHASE IIA BLOWDOWN TESTS: THE DISCHARGE OF HIGH ENTHALPY WATER FROM A SIMPLE VOLUME INTO A CONTAINMENT VOLUME. Edwards, A. R.; Jones, C. (UKAEA Safety and Reliability Directorate, Risley). 1974. 49p. Dep. NTIS (US Sales Only) $5.50. UK £1.00.

As part of a programme of work aimed at providing a better basic understanding of LWR depressurisation effects, a short series of experimental tests were performed by depressurising a simple volume through a connecting pipe into a large containment volume. An analysis of these tests is presented, which enables the mass and energy interchange flow to be deduced without initially postulating a choking flow model. The results of the analysis have been compared with the predictions of two widely used critical flow models (i.e., thermal equilibrium between phases with and without phase slip). Measurements of the rate of fall of the mixture level in the high pressure volume have also been compared with predictions from a simple bubble rise model. The main conclusions are that: (a) for a constant diameter discharge pipe, 32 mm i.d., 904 mm long, the zero slip discharge model fits the results extremely closely, but the widely used Moody slip flow model overpredicts the discharge by a factor of at least two; (b) when a small sharp-edged orifice, 22.5 mm dia., was fitted into the discharge line, the use of the Moody slip model, with a discharge coefficient of 0.6, gave close agreement, while the zero slip model badly underpredicted the flow; (c) the best fit to the mixture level measurements was given by a zero slope coefficient with a bubble separation velocity of 0.9 m/sec (3 ft/sec), rather than the widely recommended values of 0.8, and 0.9 m/sec respectively; indicating that the point of discharge can influence the choice of parameter values to be used in a computation. (auth)

14600 (TRG-Report-1197) PROBLEMS OF DETECTION OF BLOCKAGES IN THE COOLANT PASSAGES OF A FAST REACTOR BY MEASUREMENT OF COOLANT TEMPERATURE. Bentley, P. G. (UKAEA Reactor Group, Risley). Mar 1974. 21p. Dep. NTIS (US Sales Only) $4.25. UK 50 pence.

A blockage in a fast reactor sub-assembly leads to a rise in coolant outlet temperature which in principle can form the basis for a detection scheme. Rapidly developing blockages can be detected by measuring changes in coolant outlet temperature, but slow blockages are obscured by normal operational changes. Differences between coolant outlet temperatures of adjacent fuel sub-assemblies can be used to indicate large slow blockages and partial blockages produced by uniform fuel swelling, but smaller slow blockages are obscured by normal differences between sub-assemblies. Small slow blockages might be detected by a scheme based on the measurement of coolant outlet temperature fluctuations due to turbulence, which only occur when the outlet temperature profile is non-uniform. Limited theoretical information indicates that these fluctuations could occur and be detected despite the high thermal conductivity in liquid sodium. Measurements in a small air rig show that fluctuations from an idealised blockage can be detected in practice. Theoretical estimates of the sensitivity of a detection scheme for small blockages, based on temperature fluctuations, would require practical measurements in liquid sodium. (auth)

14601 (WASH-1234) ENGINEERED SAFETY FEATURES AIR CLEANING SYSTEMS FOR COMMERCIAL LIGHT-WATER-COOLED NUCLEAR POWER PLANTS (A REVIEW OF CURRENT DESIGN AND CONSTRUCTION PRACTICES). Zavadoski, R. W.; Gilbert, H.; Fuller, A. B.; Burchsted, C. A. (USAEC Directorate of Licensing, Washington, D. C.). Jun 1974. 96p. Dep. NTIS $5.45.

A report is presented on a study of air filter systems at 23 plants. The study was conducted to obtain background material for development of design, testing, and maintenance criteria. Photographs and discussions of specific features of individual air cleaning systems are used to illustrate various regulatory provisions. (DG)

14602 (WASH-1311) COMPILATION OF OCCUPATIONAL RADIATION EXPOSURE FROM LIGHT WATER COOLED NUCLEAR POWER PLANTS, 1969–1973. Murphy, T. D. (USAEC Directorate of Licensing, Washington, D. C.). May 1974. 13p. Dep. NTIS $4.00.

A compilation of occupational radiation exposures at light water cooled commercial power plants for the years 1969 through 1973 is presented. The data included are those reported by licensees except for certain calculations made by the Staff. The report shows that while the average individual exposure remains low (one rem per year) in comparison with the limits set forth in the Atomic Energy Commission's Part 20 of Title 10, Chapter 1, Code of Federal Regulations (10 CFR Part 20), Standards for Protection Against Radiation, the average exposure per plant (the cumulative exposure for all personnel at a plant) has increased from 1969 to 1973. (auth)

14603 NUCLEAR SAFETY AND TECHNICAL REGULATIONS. Queniart, D. (Ministere du Developpement Industriel et Scientifique, Paris). Ann. Mines; No. 1, 47-54(Jan 1974). (In French).

A distinction is made between protection and safety: protection generally applies to the minimization of the effects on human beings of ionizing radiation emitted by nuclear plants in normal operation; safety concerns the prediction of incidents and accidents and the limitation of the effects due to nuclear plants in normal operation. French legislation and regulations in this field are exposed. In 1973, the Ministry of Industrial and Scientific Development created a Central Service for the Safety of Nuclear Plants. The responsibilities of this service include the development of technical legislation and the organization of nuclear plant inspection. Some of the principles of American legislation are reviewed together with French legislation for different types of reactor. (FR)

14604 ENVIRONMENTAL PROBLEMS IN THE PROMOTION OF NUCLEAR POWER GENERATION AND THE COUNTERMEASURES. Sumiya, H. (Tokyo Electric Power Co. Inc.). pp 145-180 of Siting and Environmental Problems in the Development of Electric Power Stations. Its Status and Analysis. Tomioka, K. (ed.). Tokyo; Fuji International Co. (1973). (In Japanese)

Differing from the case of thermal power plants, nuclear power generation has its peculiar problems. During the operation of nuclear power plants, a tremendous amount of radioactive materials is accumulated in reactors; which, when accidentally released, cause major hazards to people. Even in normal operation, radioactive materials are released gradually. Therefore, proper measures must be taken, including the safe disposal of radioactive wastes and the monitoring of power station sites. The safety aspects of nuclear power plants in Japan, environmental problems concerned, and the countermeasures taken are described on the following: the radioactive materials accumulating in reactor plants; safety of nuclear power plants with BWRs and PWRs, including loss of coolant accidents and safety evaluation; radioactive waste disposal in nuclear power stations; the release of radioactive wastes from nuclear power stations; the measures for waste disposal; and environmental radiation monitoring. (JA)

14605 COMPARATIVE MODEL THEORY OF ATMOSPHERIC CONTAMINANT LOADING BY POWER STATIONS. Jordan, S.; Schikarski, W. (Kernforschungszentrum, Karlsruhe, Ger.). Staub-Reinhalt. Luft; 32: No. 11, 31-37(Nov 1972).

On the basis of maximum permissible concentrations, simplified box models are developed to compare air pollution from nuclear and fossil-fueled power plants. The calculations are based on emission data, vertical profiles, and basic standards of the pollutants. The pollutant body-burden of nuclear power plants is smaller than that of fossil-fueled plants. Power stations fueled with natural gas give smaller relative body burdens than those

from power plants fueled with hard coal, brown coal, and oil but larger than those from nuclear plants. Krypton-85 released from reprocessing plants is the main pollutant of nuclear power systems. (Pollut. Abstr.)

14606 WARM DRAIN WATER FROM NUCLEAR POWER STATIONS: PROBLEMS AND THE COUNTERMEASURES. Senshu, S. I. (Central Research Inst. of Electric Power Industry, Chiba, Japan). pp 181-233 of Siting and Environmental Problems in the Development of Electric Power Stations. Its Status and Analysis. Tomioka, K. (ed.). Tokyo; Fuji International Co. (1973). (In Japanese)

Various problems, chiefly environmental, are caused by the warm water released from steam condensers in nuclear power stations. The following are described: the current state of warm water problems in various countries; the different methods for cooling waste heat; estimation of warm water dispersion in the sea; actual observation of the dispersion of warm water in the sea; and the steps taken to reduce the temperature of warm water. Heat disposal for the warm water from steam condensers either returns heated water to its original source or heat is released into the atmosphere through cooling tower, pond, etc. The dispersion of warm water in the sea is estimated by means of a mathematical model. These results, however, must be confirmed by actual observations. Means to reduce the temperature of warm water are water intake and discharge for condensers at deep sea, dilution with low temperature water, and forced mixing with air bubble curtain. (JA)

14607 STUDIES ON THE SAFETY ENGINEERING DESIGN OF THE STEAM GENERATORS OF THE SNR-300. Dumm, K.; Mausbeck, H. (Internationale Atomreaktorbau GmbH (INTERATOM), Bensberg, Ger.). Kerntechnik; 16: No. 3, 121-125(Mar 1974). (In German).

Problems connected with sodium/water reactions are discussed and are used in forming the basis of the safety engineering design of sodium-heated steam generators. The mechanism and effects of damage propagation caused by small leaks are discussed together with the resulting detection criteria. The computation models used for the description of the accident design basis are checked against the results of large leak experiments on steam generator models. Also discussed are problems still requiring clarification, particularly in the small leak sector. (GE)

14608 METHOD FOR OBTAINING RADIATION EXPOSURE DUE TO A BOILING WATER REACTOR PLUME FROM CONTINUOUSLY MONITORING IONIZATION CHAMBERS. Gogolak, C. V.; Miller, K. M. (Atomic Energy Commission, New York). Health Phys.; 27: No. 1, 132-134(Jul 1974).

Factors contributing to the time variation of the output of a continuously monitoring chamber measuring increases in exposure rate due to gaseous effluents from nuclear facilities are considered. A method is described which may be used with any continuously monitoring device to isolate time variations which are long compared to random fluctuations in the system, at a considerable saving in time and effort over manual data reduction. (UK)

14609 PRODUCTION OF NUCLEAR ORIGIN ELECTRICITY. Reliability and Safety. Girard, Y. (Ministere de Developpement Industriel et Scientifique, Paris); Gaussot, D. Ann. Mines; No. 1, 13-20(Jan 1974). (In French).

It is projected that by the year 2000, nuclear energy will supply between 40 and 45% of French energy requirements. Emphasis is given to the importance of reliability in all types of power plants (both nuclear and nonnuclear). Nuclear power plants are provided with devices for minimizing the consequences of accidents and protecting the system from further failure. A level of reliability not encountered in most other industrial sectors is achieved in this way. (FR)

14610 SAFETY ANALYSIS AND CORRESPONDING STUDIES. Lelievre, J. (CEN de Saclay, Gif-sur-Yvette, France). Ann. Mines; No. 1, 55-60(Jan 1974). (In French).

Engineers possessing two types of expertise are required for nuclear reactor safety studies: engineers possessing a general knowledge of all the different problems encountered; engineers capable of providing specialized expertise working in conjunction with the former. Some examples are presented of safety studies carried out for ordinary water reactors and fast neutron reactors as well as general studies not limited to any particular type of reactor. (FR)

14611 REACTOR SAFETY AND SITING. Tanguy, P. (CEN de Saclay, Gif-sur-Yvette, France). Ann. Nucl. Sci. Eng.; 1: No. 3, 203-207(Mar 1974).

The technical safety assessment necessary for the authorization of a nuclear plant by public authorities is examined. The method of conducting the analysis is discussed and various concepts based on accident prevention, which are generally agreed upon as a basis for analysis, are summarized. The increasing trend towards the introduction of probability notions and some of the problems involved in the use of reliability techniques are discussed. The need is emphasized for better exchange of information, internationally, on reactor operating experience, which must be taken into account in technical safety assessments for new plants. The role of safety research is discussed and some specific aspects of siting are considered. (UK)

Reactor Theory and Calculation

14612 (IKE-4-10) ABBRAND: A MODULAR CODE FOR BURNUP CALCULATIONS IN RSYST-I. Wohland, H.; Ruehle, R. (Stuttgart Univ. (TH) (F.R. Germany). Inst. fuer Kernenergetik). Oct 1972. 42p. (In German). INIS.

Modular program systems are particularly well suited for various burnup calculations. One of the main components of such systems are modular codes describing the reactor statics which are used to determine the neutron flux density as a function of energy and position, and a burnup module to calculate the time-dependent change of the isotopic composition. The modular-code ABBRAND is described. Its functions and structure as well as its application in RSYST, combined with other modular codes for the performance of burnup calculations, are presented. An example is given illustrating the formulation and automatic realization of a burnup calculation model. (GE)

14613 (IKE-4-12) RSYST: AN INTEGRATED MODULE SYSTEM WITH DATA FILE FOR THE AUTOMATED CALCULATION OF NUCLEAR REACTORS. Ruehle, R. (Stuttgart Univ. (TH) (F. R. Germany). Inst. fuer Kernenergetik). 9 Jul 1973. 151p. (In German). INIS.

Thesis.

The integrated module system RSYST has been developed in order to make a simple carrying out of design calculations for nuclear reactors possible. The system consists of a data base, a control part and data base administration programme, as well as an unlimited number of modules. The transfer of data between individual modules takes place through the data base administration programme over the central data base. Control terms in the input allow the user to control the running of any desired module series. Flexible data of the data base can be assigned to every module. By means of special modules, logical branching and loops can be realized. At the moment, besides general modules, especially the modules for reactor statistics, burn-up and shielding calculations, and for the production of group constants have been realized. A start has been made to include problems of heat conduction, thermohydraulics, reactor safety, control technique and loop dynamics. (GE)

14614 (MRR-110) PRELIMINARY INVESTIGATIONS FOR THE DETERMINATION OF THE REACTOR TRANSFER FUNCTION BY MEANS OF BINARY PSEUDORANDOM SIGNALS. Neuenhahn, P.; Wach, D. (Technische Univ. Muenchen, Garching (F. R. Germany). Lab. fuer Reaktorregelung und Anlagensicherung). Nov 1972. 80p. (In German). INIS.

Various methods for the experimental analysis of the dynamic behavior of nuclear reactors are discussed and critically compared. The binary pseudo-random signal is well suited as a test signal for those measurements. The characteristic properties of the binary pseudo-random signal are discussed, the failures occurring during the measurement and the analysis are estimated. As a result of investigations recommendations for measurements at the reactor are given. (GE)

14615 PREDICTION OF GAMMA-RAY SPECTRA AT DEEP PENETRATION UTILIZING THE EQUILIBRIUM ANGULAR DISTRIBUTION. Johnson, D. M. (Berkeley Nuclear Labs., Eng.). Nucl. Sci. Eng.; 54: No. 3, 235-253(Jul 1974).

In reactor design there is a requirement for a practical and economic method of predicting gamma-ray spectra throughout bulk shields. The commonly used build-up factor technique suffers the disadvantage of not predicting primary physical quantities, and the more sophisticated transport methods require considerable computer time and expertise to be effective. In the method developed, an order of scattering model has been used with a spatial cell scheme and an energy multigroup system, but the usual limitation of computational complexity has been overcome by an angular approximation. An equilibrium property in the behavior of the angular penetration spectra has been incorporated in an anisotropic scatter approximation which tends, in the low energy limit, to become isotropic. The code has been tested over a range of penetrations and source energies, and the results are compared with the Monte Carlo method; similar results through an interface are given. Extension of the model to more complex geometries has been considered briefly. (auth)

14616 THEORY FOR PULSED-NEUTRON EXPERIMENTS IN REACTOR LATTICES. van Binnebeck, J. J. (Univ., Brussels). Nucl. Sci. Eng.; 54: No. 3, 341-352(Jul 1974).

Using the asymptotic transport theory and the reactor image method in a reactor lattice, group theory is applied to develop a solid-state physics formalism, generalizing Nelkin's theory for homogeneous media. The eigenvalues of the transport operator are shown to be classified according to the representations of the lattice symmetry group, while the corresponding flux eigenfunctions form a basis for those representations. These flux eigenfunctions have a Bloch form that can be interpreted as a factorization of the flux into a macroscopic and a microscopic shape. Finally, the transport eigenvalue problem is shown to be reduced to a unit cell eigenvalue problem for a modified transport equation, the resolution of which can be simplified by symmetry considerations in the choice of trial functions for some variational principle. (auth)

14617 THRESHOLD INSTABILITY OF A REACTOR WITH RESPECT TO THE ONSET OF SPATIAL XENON OSCILLATIONS. Semenov, V. N. Sov. J. At. Energy (Engl. Transl.); 34: No. 1, 37-38(Jan 1973).

Translated from At. Energ. (USSR); 34: No. 1, 30(Jan 1973). This is a summary of paper No. 634/6683 with full copy held by TIC.

A study of the practical stability of a reactor with respect to the onset of spatial xenon oscillations shows that the amplitude of the steady-state oscillations and the allowance for the loss of stability depend on the sign and magnitude of the nonlinear terms, which in ordinary linear analysis are discarded. It is shown that in reactors with an inhomogeneous core it is possible to have an instability of the threshold type (e.g., a reactor that is stable with respect to small perturbations loses its stability for perturbations of sufficiently large amplitude). Allowance for the loss of stability depends on the magnitude of the inhomogeneity of the core and the magnitude of the damping coefficient, calculated in the linear approximation. (auth)

14618 XENON-INDUCED SPATIAL POWER OSCILLATIONS IN POWER REACTORS. Rydin, R. A.; Barron, H. B. Jr. (Univ. of Virginia, Charlottesville). pp 12.1-12.20 of Power Plant Dynamics, Control, and Testing. Knoxville, TN; Univ. of Tennessee (1973).

From an applications symposium on power plant dynamics, control and testing; Knoxville, Tennessee, USA (8 Oct 1973). See CONF-731021-.

Methods of analyzing xenon-induced spatial power oscillations in power reactors are discussed. Three-dimensional analysis and the use of the NOXE 3 nodal code are described. 23 references. (DCC)

14619 ELEMENTARY SOLUTIONS OF THE NEUTRON TRANSPORT EQUATION. Shulaya, D. A. (Tbilisi State Univ., USSR). Soobshch. Akad. Nauk Gruz. SSR; 73: No. 3, 533-536 (Mar 1974). (In Russian).

Fundamental solutions of the neutron transport equation in plane geometry in the case of isotropic scattering and energy dependence is considered. (5 references) (auth)

14620 PROBLEMS OF OPTIMAL BURNING-OUT OF SAMARIUM-149 IN SHUTTING DOWN A HIGH-FLUX REACTOR WITH ACCOUNT OF IRREGULAR NEUTRON FLUX DISTRIBUTION. Gol'dbaum, N. I. (Scientific-Research Inst. of Instrument Manufacturing and Means of Automation, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR; 73: No. 3, 649-652(Mar 1974). (In Russian).

The problem of the optimal transition process of the burning-out of Sm-149 in shutting-down a high-flux reactor with account of irregular neutron flux distribution is considered. (auth)

14621 THEORY OF POWER REACTOR NOISE. III. Saito, K. (Hokkaido Univ., Sapporo). Ann. Nucl. Sci. Eng.; 1: No. 3, 209-221(Mar 1974).

Knowledge of space-dependent at-power reactor noise is accumulating, and in order to determine which of the many localized noise phenomena are treated by the distributed model, an examination is made of both the basic and practical theoretical analytical procedures which have been adopted. (UK)

14622 STABILITY OF COUPLED-CORE NUCLEAR REACTORS. Noldus, E. J. Eng. Math.; 6: No. 1, 31-35(Jan 1972).

Reactor Components and Accessories

14623 (EURFNR-1172) CONSIDERATIONS FOR A EUROPEAN CENTRALIZED RELIABILITY DATA BANK SYSTEM. Cardarola, L. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Angewandte Systemtechnik und Reaktorphysik). Oct 1973. 13p. (EUR-4972). Dep. NTIS (US Sales Only) $4.00.

Work performed under United States–Euratom Fast Reactor Exchange Program.

Today's reliability data banks are still unsatisfactory. The disadvantages of these banks are briefly analyzed and it is concluded that future banks may improve the quality of their services, if they are more specialized, and connected through a centralized system. In this way it should be possible to satisfy the more severe reliability requirements which are continuously requested for technological applications in highly reliable systems, such as energy systems, transportation systems and computer industry. This can be obtained by a high degree of knowledge of the device's properties based on past experience. In order to acquire this high degree of knowledge, the knowledge of the manufacturer and that of the user must merge together through an integrated learning process. This process requires the complete exchange of information between the manufacturer of a given device and the user. In the case of replaceable devices, new (not yet used) devices will be tested only initially in order to provide sufficient knowledge to render the devices operationable. Later, since the preventative maintenance policy will be currently adopted, lifetests will be carried out preferably on used devices, which were dismissed before failure after having been used for the allowed length of time. It turns out that the learning process takes in this case the form of a cycle. The cycle begins when a new device starts operation in the user's plant, and it ends when the information gained from the lifetests, carried out in the laboratory on the same device (now called "used device"), reaches the user through the "bank". Information will be produced continuously, and the speed of learning will be a function of the flow of devices in the cycle, that is to the ratio between the number of devices present in the cycle and their residence time in the cycle. Various strategies of learning are therefore possible, and some of them are also discussed. The motivations for establishing a centralized system are analyzed, and the associated problems are discussed. (auth)

14624 (ORNL-4732) ANALYTICAL STUDY OF INSIDE AND OUTSIDE COMPACT REINFORCEMENT FOR RADIAL NOZZLES IN SPHERICAL SHELLS. Gwaltney, R. C.; Corum, J. M. (Oak Ridge National Lab., Tenn. (USA)). Jun 1974. Contract W-7405-eng-26. 55p. AT.

Compact reinforcement for a series of models having single nozzles radially attached to spherical shells was examined by the finite-element method. Parameters studied were diameter-to-thickness ratios of the nozzles and of the spherical shells, percentage reinforcement, outside reinforcement, inside reinforcement, and combined reinforcement (i.e., on both the inside and outside surfaces). Twenty-two models were analyzed to examine the effect of compact reinforcement under internal pressure loading. Comparisons of theoretical predictions with experimental results are presented for one reinforced model. (auth)

14625 (ORNL-TM-4269) STRESS ANALYSIS OF A RADIAL NOZZLE ATTACHED TO A CYLINDRICAL SHELL UNDER INTERNAL PRESSURE. Edmondson, A. J. (Oak Ridge National Lab., Tenn. (USA)). May 1974. Contract W-7405-eng-26. 64p. Dep. NTIS $5.45.

An analytical method for the determination of stresses in the region of intersection of a thin-walled composite shell made from two right circular cylinders intersecting with axes perpendicular and subjected to internal pressure is presented. The governing equations are based on shallow, thin-shell theory and are limited to a ratio of cylinder radii of one-third or less. The formulations are written in terms of dimensionless groups to facilitate use of the analysis method in conducting parameter studies. Comparisons are made between the results obtained using the method and experimental data. The results of the investigation indicate that the analysis should prove to be a useful tool for conducting parametric studies within the specified range of validity. (auth)

14626 POWER PLANT DYNAMICS AND MALFUNCTION DETECTION. Saxe, R. F. (North Carolina State Univ., Raleigh). pp 16.1-16.6 of Power Plant Dynamics, Control, and Testing. Knoxville, TN; Univ. of Tennessee (1973).

From an applications symposium on power plant dynamics, control and testing; Knoxville, Tennessee, USA (8 Oct 1973). See CONF-731021-.

The development of an automatic system for malfunction detection in a power reactor is described. Reactor parameters to be monitored and types of sensors required are discussed. 3 references. (DCC)

14627 TECHNICAL MECHANICS IN REACTOR TECHNOLOGY. Report on the Second International Conference on Structural Mechanics in Reactor Technology. Brandes, K.

(Bundesanstalt fuer Materialpruefung, Berlin). Atomwirt., Atomtech.; 14: No. 1, 36-39(Jan 1974). (In German).

From second international conference on structural mechanics in reactor technology; Berlin, Germany (10 Sep 1973).

Two years after the first conference in the series "Structural Mechanics in Reactor Technology (SMiRT)"; the second one took place in Berlin from 10.-14.9.73, organized by the International Association for Structural Mechanics in Reactor Technology together with the Commission of the European Communities and the Bundesanstalt fuer Materialpruefung (BAM). The object of this organization is to improve the contact between engineers and scientists working in reactor technology in solving problems on the mechanical behavior of reactor components, and to produce the basic scientists of technical mechanics. A short summary of the conference results is given. (GE)

14628 EXPERIMENTAL INVESTIGATION OF INTERFACE SHEAR TRANSFER AND APPLICATIONS IN THE DYNAMIC ANALYSIS OF NUCLEAR CONTAINMENT VESSELS. Laible, J. P. Ithaca, NY; Cornell University (1973). 347p. University Microfilms Order No. 74-10,857.

Thesis (Ph. D.).

The current criteria for the design of conventionally reinforced concrete nuclear containment vessels requires that the structure be designed to withstand the simultaneous occurrence of an internal pressurization and the inertia forces generated by a strong motion earthquake. Under these conditions crack planes in the concrete wall (in the horizontal and vertical directions) will have formed due to the internal pressure. The cyclic shearing forces due to a seismic excitation must then be transmitted along these planes. The investigation carried out had a two-fold purpose: to investigate the shear capacity along crack planes of large segments of concrete and to assess the effect of a number of variables on the behavior of this mode of shear resistance, hereafter referred to as Interface Shear Transfer (IST); and to assess the effect of this mode of shear resistance on the dynamic response of a typical orthogonally reinforced nuclear containment vessel due to a seismic excitation. (Diss. Abstr. Int., B)

14629 USE OF GAS TURBINES IN NUCLEAR HEAT-AND-POWER PLANTS. Bortlik, J. Bull. EGU; No. 78, 16-17(1973). (In Czech).

The progressive development of high-temperature reactors and the introduction of gas turbines in power engineering produce technical conditions for the realization of nuclear heat source on the stated basis. An analysis of the conditions underlying prospective applications of heat-and-power plants equipped with gas turbines is presented. Some possible solutions of the problem are discussed. (auth)

14630 APPLICATION OF SMALL DIGITAL COMPUTERS IN THE MEASUREMENT OF REACTIVITY. Mogil'ner, A. I.; Fokin, G. N.; Chaika, Yu. V.; Kuznetsov, F. M. At. Energ. (USSR); 36: No. 5, 358-362(May 1974). (In Russian).

The feasibility of using small on-line or off-line digital computers in the measurement of reactivity is shown. The measurement of reactivity is based on an inverse form of kinetic equations permitting from known changes in reactor power with given quantization simply and accurately to calculate the concentration of delayed neutron precursors and reactivity. The new method of independent and simultaneous measurement of reactivity and neutron source from analysis of the drop in power after changing the reactivity (for example after rod displacement) is described. The possibility of independent neutron source measurement extends the algorithm of reactivity measurement to subcritical reactors. Experimental data are presented. 4 references. (auth)

14631 IEEE STANDARD CRITERIA FOR CLASS IE POWER SYSTEMS FOR NUCLEAR POWER GENERATING STATIONS. New York; Institute of Electrical and Electronics Engineers, Inc. (1974). 12p. (IEEE-Std-308-1974).

This standard applies to the electric systems in stationary single-unit and multi-unit nuclear power generating stations that provide electric power to the Class IE equipment. The electric systems included are comprised of the following interrelated systems: (1) alternating-current power systems; (2) direct-current power systems; (3) vital instrumentation and control power systems. These systems consist of power supplies (for example, standby generators and batteries), distribution equipment, and components (for example, transformers, switchgear, bus, cable, battery chargers, and inverters), and their associated instrumentation and controls (for example, relays, meters, switches, and control devices). (auth)

14632 IEEE STANDARD FOR TYPE TEST OF CLASS IE ELECTRIC CABLES, FIELD SPLICES, AND CONNECTIONS FOR NUCLEAR POWER GENERATING STATIONS. New York; Institute of Electrical and Electronics Engineers, Inc. (1974). 15p. (IEEE-Std-383-1974).

This standard provides direction for establishing type tests which may be used in qualifying Class IE electric cables, field splices, and other connections for service in nuclear power generating stations. General guidelines for qualifications are given in IEEE Std 323-1974, Standard for Qualifying Class IE Electric Equipment for Nuclear Power Generating Stations. Categories of cables covered are those used for power control and instrumentation services. Though intended primarily to pertain to cable for field installation, this guide may also be used for the qualification of internal wiring of manufactured devices. (auth)

14633 LOOK AT FORGED VALVES FOR NUCLEAR. Velan, A. K. Power; 117: No. 9, 43-45(Sep 1973).

A valve in nuclear service must provide maximum reliability, and safety, functional, and interface requirements of the cooling system. Some considerations that are basic to design include simplicity, proven components, materials, liberal load and stress margins, leakage elimination, contamination and degradation, easy assembly and installation, and simple maintenance and in-service inspection. The preference for forgings, rather than castings, is discussed. The characteristics of five basic body-bonnet joints and three steam seals are discussed for nuclear service. (MCW)

Reactor Fuels

Refer also to abstracts 12419-12423, 13078, 13104, 13129, and 13144.

14634 (AAEC/E-308) CALCULATIONS AND REVIEW OF CRITICALITY DATA FOR HOMOGENEOUS, WATER-MODERATED, 5 WEIGHT PER CENT ENRICHED URANIUM DIOXIDE SYSTEMS. Cripps, P. B. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Apr 1974. 27p. Dep. NTIS (US Sales Only) $4.50.

The published data on 5 weight per cent enriched uranium dioxide systems are reviewed and compared with AAEC computed values. The accuracy of the computation is dependent on both the calculational methods and nuclear data used. Both are treated in some detail. (auth)

14635 (INIS-mf-1119) IRRADIATION OF U(C,N) FUEL IN BR2-EXPERIMENTS. Herren, M.; Naoumidis, A.; Pott, G. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Inst. fuer Reaktorbrennelemente). 1973. 12p. INIS.

From symposium on the results of five years of BR2 reactor utilization; Mol, Belgium (4 Dec 1973).

Since 1968 U(C,N) fuel pins were tested in six experiments at BR2 Mol. Two additional tests are now under preparation. The existing irradiation facilities had to be modified for heat ratings of 1500 W/cm fuel pin length. In long term irradiations a burnup of more than 50,000 MWd/tU was achieved. The fuel irradiation behaviour was similar to results obtained for UC. The program will be finished in 1974. (auth)

14636 (INIS-mf-1121) BEHAVIOR OF URANIUM OXIDE FUEL CONTAINING BURNABLE POISONS. Flipot, A. J.; Delbrassine, A.; Gilissen, R. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). 1973. 13p. INIS.

From symposium on the results of five years of BR2 reactor utilization; Mol, Belgium (4 Dec 1973).

Incorporation of Dy_2O_3 and Gd_2O_3 as burnable poisons in the form of a uniform dispersion into UO_2 has been studied in view to increase the lifetime of fuel elements. Small amounts of impurities as aluminium or titanium oxide were found to accelerate the solid solution formation between UO_2 and Dy_2O_3 or Gd_2O_3. Irradiations tests have shown that the fuel with a burnable poison dispersion has a good stability and that the titanium oxide strongly improves the homogeneity of the fuel without adverse effect on the fuel behavior. (auth)

14637 (INIS-mf-1124) COATED PARTICLES IRRADIATION IN THE BR2 REACTOR. Gaube, M. (Societe Belge pour l'Industrie Nucleaire, Brussels). 1973. 17p. INIS.

From symposium on the results of five years of BR2 reactor utilization; Mol, Belgium (4 Dec 1973).

The Belgian Materials Testing Reactor BR2 has been used for our HTR fuel irradiation programme since 1965. The experiments carried out during the period 1969-1973 are described. Four types of rigs have been utilized: hydraulic rabbits capsules to carry out transient tests; a boiling water capsule to study the evolution of the bonded fuel thermal conductivity; the lower extension of the MFBS-6 in-pile sodium loop to irradiate compacts and particles; and vented capsules to irradiate particles, compacts and coupons in collaboration with KFA, the Dragon Project and Euratom. The doses and burnup reached at the end of 1973 by the different low enriched and highly enriched and plutonium fuel irradiations are given. (INIS)

14638 (INIS-mf-1127) COMPATIBILITY BETWEEN OXIDE FUEL AND CLAD MATERIAL. Delbrassine, A.; Hebel, W.; Dirven, P.; Huet, J. J. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). 1973. 7p. INIS.

From symposium on the results of five years of BR2 reactor utilization; Mol, Belgium (4 Dec 1973).

Some years ago, sporadic intergranular corrosion and clad ablations have been observed at the inner clad surface of the experimental mixed oxide fuel rods. Both forms of attack occur only above an inner clad temperature of 500°C and a burnup as low as 40,000 MWd/t. This corrosion appears under certain combinations of inner clad temperature, burnup and fuel composition. There are little references in the open literature to the role played by cladding material composition; the presence of carbon and/or oxygen stabilizers could influence the corrosion depth. However, no systematic clad rupture has been attributed to this form of corrosion. From thermodynamic considerations, the mixed oxide fuel $(U_{0.8}Pu_{0.2})O_{1.99}$ is compatible with stainless steel which is usually chosen as cladding material. Experiments have shown that hyperstoichiometric oxide fuel oxidizes the most important cladding components: Cr and Fe, whereas in stoichiometric and hypostoichiometric fuel, the oxygen activity level is too low to oxidize the clad. (INIS)

14639 (KFK-1521) SHORT-TERM IRRADIATION OF OXIDE FUEL PINS OF THE FR 2 He-LOOP GROUP NO. 2: SPECIFICATION, FABRICATION, IRRADIATION, POSTIRRADIATION EXAMINATION, AND ANALYSIS. Hoffmann, H.; Geithoff, D.; Gerken, A. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Material- und Festkoerperforschung). Dec 1973. 362p. (In German). Dep. NTIS (US Sales Only) $21.25.

The aim was to study the restructuring of the fuel, especially the formation of the central hole and the columnar grain zone within the first hours of irradiation. In addition, the influence of partly molten fuel on the cladding and the diameter changes of cladding after gap closure were to be analyzed. "He-Loop-Group 2" consisted of 43 fuel pins successively irradiated in FR 2 from October 1966 till November 1968. Irradiation was performed in an instrumented central loop with flowing He as a coolant. The fuel pins contained 75% enriched UO_2 fuel in the form of pellets (with and without dishings) or vibrocompacted particles. The short pins with pellets were 177 mm long with gas plenum at the top. The pins with vibrocompacted particles (182.5 mm long) had no plenum. The austenitic stainless steel cladding had an outer diameter of 12 mm and 1 mm wall thickness. The fuel pins had been irradiated at various linear rod powers (500, 750, and 1000 W/cm) and over different irradiation times (10 min, 2 h, 24 h). The cladding surface temperatures lay between 500 and 620°C. In spite of the high linear rod powers and extended melting zones, all pins remained intact during irradiation. No diameter increase of the cladding was detected. Attempts at measurements of the gas pressure and the central temperature were not successful. This report includes not only the detailed documentation of the fabrication, irradiation and post-irradiation data, but also the results of thermal analysis. The thermal analysis carried out at a lower and a central fuel pin cross section gives the following results: Calculated temperature profiles are not in good agreement with the temperatures of the radial structures. The heat transfer fuel/cladding turned out to be a function of the linear rod power (contact pressure). The temperature for the formation of columnar grain zones shows the dependence of the linear rod power and the irradiation time. (auth)

14640 EFFECT OF A CHANGE IN NON-UNIFORM ENERGY RELEASE IN THERMAL REACTOR FUEL ON THE TEMPERATURE DISTRIBUTION IN THE FUEL ELEMENT. Yamnikov, V. S.; Malanchenko, L. L.; Solyanyi, V. I. At. Energ. (USSR); 36: No. 4, 269-272(Apr 1974). (In Russian).

There is obtained an analytical solution of the heat-transfer equation for the cladding and fuel of a cylindrical fuel element, taking into account non-uniform energy release distribution across the fuel due to plutonium accumulation in the outer layers. An approximation for the probability distribution of avoiding resonance absorption over the fuel radius, permitting the energy release redistribution to be calculated, is derived. As an example, the heat calculation for a fuel element is presented. The fuel temperature is shown to decrease as a result of plutonium accumulation. (auth)

14641 METHOD OF FABRICATING A NUCLEAR REACTOR FUEL ELEMENT. Woolsey, C. C. Jr. (to United States Atomic Energy Commission). US Patent 3,809,731. 7 May 1974. Filed date 31 Mar 1961. 4p.

An improved method of fabricating uranium–zirconium hydride fuel element and a method for protecting the fuel element from interaction with the cladding material at high temperatures consists of preparing a Zr–U alloy, enclosing the alloy in a sleeve of Zr metal and then hydriding to yield a U–Zr alloy hydride fueled core clad with a protective zirconium hydride outer region. The resulting fuel rod is then enclosed in a conventional protective tubing such as stainless steel. This provides a barrier material between the fuel-moderator material and the cladding and prevents eutectic formation with the U fuel. (FS)

14642 NUCLEAR FUEL CYCLE. Hoechel, J.; Matz, G.; Schweikert, H.; Weidinger, H. Schriftenreihe des Deutschen Atomforums, Volume 19. Bonn; Deutsches Atomforum (1972). 144p. (In German).

A detailed description is given of the entire fuel cycle, along with numerous tables, diagrams and illustrations. The various sections discussed are: fuel supply, uranium enrichment, fuel elements (design and manufacturing), transport of nuclear fuels, reprocessing, waste treatment and ultimate storage of radioactive wastes. (GE)

Reactor Control Systems

14643 (CEA-BIB-211) ELECTRONIC EQUIPMENT FOR CONTROL AND MONITORING OF NUCLEAR REACTORS. (CEA Centre d'Etudes Nucleaires de Saclay, 91-Gif-sur-Yvette (France)). May 1974. 25p. (In French). (CONF-740333-1). Dep. NTIS (US Sales Only) $4.25.

From meeting on electronic equipment for control and monitoring of nuclear reactors; Saclay, France (8 Mar 1974).

The program of the March 8, 1974, Saclay meeting on nuclear reactor instrumentation is given together with abstracts of the eleven papers presented. A bibliography of documents and publications on nuclear reactor control is included. (DG)

14644 (N-73-33595) FABRICATION OF CERMET BEARINGS FOR THE CONTROL SYSTEM OF A HIGH TEMPERATURE LITHIUM COOLED NUCLEAR REACTOR. Yacobucci, H. G.; Heestand, R. L.; Kizer, D. E. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). Oct 1973. 31p. (NASA-TM-X-2892; E-7500). NTIS $3.00.

The techniques used to fabricate cermet bearings for the fueled control drums of a liquid metal cooled reference-design reactor concept are presented. The bearings were designed for operation in lithium for as long as 5 years at temperatures to 1205 C. Two sets of bearings were fabricated from a hafnium carbide–8-wt % molybdenum–2-wt % niobium carbide cermet, and two sets were fabricated from a hafnium nitride–10-wt % tungsten cermet. Procedures were developed for synthesizing the material in high purity inert-atmosphere glove boxes to minimize oxygen content in order to enhance corrosion resistance. Techniques were developed for pressing cylindrical billets to conserve materials and to reduce machining requirements. Finishing was accomplished by a combination of diamond grinding, electrodischarge machining, and diamond lapping. Samples were characterized in respect to composition, impurity level, lattice parameter, microstructure and density. (auth)

14645 EXPERIMENTAL INVESTIGATION OF SINGLE-STAGE CONTROL CIRCUIT OF COOLANT OUTLET TEMPERATURE IN THE BOR-60 REACTOR. Afanas'ev, V. A.; Gryazev, V. M.; Efimov, V. N. Sov. J. At. Energy (Engl. Transl.); 34: No. 1, 38-39(Jan 1973).

Translated from At. Energ. (USSR); 34: No. 1, 30-31(Jan 1973). This is a summary of paper No. 635/6888 with full copy held at TIC.

Automatic control systems of the power of nuclear energy plants with fast reactors do not always prevent the occurrence of dangerous thermal stresses in constructional elements of the reactor and its associated equipment. In the control circuits described, the control parameter is not the reactor neutron power but the coolant temperature at the reactor outlet. Such control systems reduced temperature fluctuations, caused by variation of the input parameters, in the reactor core and in the entire power plant. The BOR-60 fast reactor has been used in the design and testing of a single-stage coolant outlet temperature control system employing a commercial RPI regulator. The error signal from the temperature setter and thermocouples at the reactor outlet was balanced by activating the control rods through a relay converter. The system was tested with the neutron power control circuit disconnected. The system provided smooth regulation practically without overshoots in the presence of fluctuations of temperature ($\pm 25.10^{-15}$ $\Delta C/C$), coolflow rate (± 100 m^3/h), and loading ($\pm 20\%$). (auth)

14646 POWER PLANT DYNAMICS, CONTROL, AND TESTING. Symposium Held in Knoxville, Tennessee, October 8-10, 1973. Knoxville, TN; University of Tennessee (1973). 366p. (CONF-731021-). $25.00.

Separate abstracts are included for 16 of the papers presented concerning control and testing systems for nuclear power plants. (DCC)

For abstracts of individual papers see: 14504, 14505, 14512, 14525, 14549, 14618, 14626, and 14647–14655.

14647 CANADIAN EXPERIENCE IN COMPUTER CONTROL OF NUCLEAR PLANTS. Whittall, W. R.; Hinchley, E. M. (Atomic Energy of Canada Ltd., Clarkson, Ont.). pp 5.1-5.14 of Power Plant Dynamics, Control, and Testing. Knoxville, TN; Univ. of Tennessee (1973).

From an applications symposium on power plant dynamics, control and testing; Knoxville, Tennessee, USA (8 Oct 1973). See CONF-731021-.

The computer control systems of the Pickering and Gentilly reactors are described. The functions of the control systems include reactor power control, heat transport system pressure and level control, boiler pressure and level control, generator load control, turbine run-up control, fuelling machine control, fuel transfer system control, alarm scanning and display, and data display and logging. 15 references. (DCC)

14648 HYBRID SIMULATION OF A DIRECT-CYCLE HIGH-TEMPERATURE REACTOR. Deat, M.; Felix, M.; Justin, F. (CEN, Saclay, France). pp 8.1-8.7 of Power Plant Dynamics, Control, and Testing. Knoxville, TN; Univ. of Tennessee (1973).

From an applications symposium on power plant dynamics, control and testing; Knoxville, Tennessee, USA (8 Oct 1973). See CONF-731021-.

The dynamics of a direct-cycle nuclear plant are simulated on an EAI 8900 hybrid computer and the control of the reactor is studied. The unit examined consists of: a reactor of very high output temperature, cooled by a helium flow acting directly on the utilization circuit; two compressors and two turbines, one of which drives an alternator; and heat exchangers. The dynamics of the plant are described and the mathematical model is set up. (auth)

14649 NUCLEAR DUAL-PURPOSE DESALINATION PLANT SIMULATOR. Delene, J. G. (Oak Ridge National Lab., TN). pp 10.1-10.15 of Power Plant Dynamics, Control, and Testing. Knoxville, TN; Univ. of Tennessee (1973).

From an applications symposium on power plant dynamics, control and testing; Knoxville, Tennessee, USA (8 Oct 1973). See CONF-731021-.

The U. S. Atomic Energy Commission sponsors a program at Oak Ridge National Laboratory (ORNL) to investigate the possible coupling and control problems of nuclear dual-purpose plants so as to ensure that large plants now being developed will operate satisfactorily when built and placed in operation. As an aid to understanding and predicting their response, a series of digital simulators was developed at ORNL. These simulators can calculate the response of the dual-purpose plants to input perturbations, and are used to study the system responses to normal operational changes and certain component failures. The results of such calculations can be used to determine the adequacy of control systems and plant layout schemes and to ascertain what needs to be done to insure that such a plant will operate smoothly. Some results are given showing typical responses obtained with the simulator. 6 references. (auth)

14650 DYNAMIC ANALYSIS AND CONTROL SYSTEM DESIGN OF A LMFBR PLANT. Furuichi, K.; Kohata, Y.; Nakamura, K.; Kitamura, M.; Kishida, K. (Mitsubishi Atomic Power Industries, Inc., Tokyo). pp 13.1-13.13 of Power Plant Dynamics, Control, and Testing. Knoxville, TN; Univ. of Tennessee (1973).

From an applications symposium on power plant dynamics, control and testing; Knoxville, Tennessee, USA (8 Oct 1973). See CONF-731021-.

Through the design of a control system and its simulation study using PDAC-6, the plant dynamics of LMFBRs is studied in detail. The control system proposed is a conservative design. 7 references. (auth)

14651 HTGR DYNAMIC MODELING AND TESTING. Leech, W. D. (Gulf General Atomic Co., San Diego, CA). pp 14.1-14.10 of Power Plant Dynamics, Control, and Testing. Knoxville, TN; Univ. of Tennessee (1973).

From an applications symposium on power plant dynamics, control and testing; Knoxville, Tennessee, USA (8 Oct 1973). See CONF-731021-.

An HTGR Dynamic Testing Program currently under development at Gulf General Atomic is described. The testing program involves designing, performing, and analyzing frequency response tests on Public Service Company of Colorado's Fort St. Vrain nuclear power station. The tests will involve perturbing appropriate system variables with small periodic signals and measuring the output amplitude and phase of other system variables. Data from the tests will be used to further verify and improve existing methods and dynamic models used in the design of an HTGR nuclear steam supply system. A linear program used for control analysis and a nonlinear code used for plant dynamic analysis will be subjected to the test data. 4 references. (auth)

14652 SIMULATION STUDY OF A DIAGNOSTIC SYSTEM OF NUCLEAR REACTOR. Ina, S.; Yoshikawa, H.; Wakabayashi, J. (Kyoto Univ.). pp 21.1-21-23 of Power Plant Dynamics, Control, and Testing. Knoxville, TN; Univ. of Tennessee (1973).

From an applications symposium on power plant dynamics, control and testing; Knoxville, Tennessee, USA (8 Oct 1973). See CONF-731021-.

A new concept of diagnostic system of nuclear reactors is described which is based on the multivariate statistical analysis. This study is relevant to the determination and prediction stages. In this system, all the detector signals of neutron flux, temperature, flow, etc. are simultaneously analyzed by pattern recognition technique. The reactor operation is always monitored and classified into the categories of the normal state and several abnormal states which are characterized by the causes of the abnormalities. Then the magnitude of abnormality is estimated by the simplified dynamic model which is identified beforehand by using methods of Laqueere expansion and multiple regression analysis. The future development of the present abnormal state would be easily predicted from these estimated informations. 10 references. (auth)

14653 APPLICATION OF PATTERN RECOGNITION METHODS TO REACTOR MALFUNCTION DIAGNOSIS. Gonzalez, R. C. (Univ. of Tennessee, Knoxville). pp 25.1-25.17 of Power Plant Dynamics, Control, and Testing. Knoxville, TN; Univ. of Tennessee (1973).

From an applications symposium on power plant dynamics, control and testing; Knoxville, Tennessee, USA (8 Oct 1973). See CONF-731021-.

Results are presented in the application of unsupervised pattern recognition methods to the problem of malfunction detection in power reactors. Experiments with neutron noise measurements in the High Flux Isotope Reactor of the Oak Ridge National Laboratory illustrate the potential of pattern recognition techniques as an integral part of a computer-aided performance surveillance system for nuclear power plants. 9 references. (auth)

14654 ANOMALY DETECTION SYSTEM FOR NUCLEAR POWER PLANTS. Kato, K. (Hitachi Ltd., Kawasaki, Japan). pp 26.1-26.12 of Power Plant Dynamics, Control, and Testing. Knoxville, TN; Univ. of Tennessee (1973).

From an applications symposium on power plant dynamics, control and testing; Knoxville, Tennessee, USA (8 Oct 1973). See CONF-731021-.

In order to meet increasing safety requirements of the nuclear power plants, an anomaly detection system (ADS) is developing for the boiling water reactor. The system intends to detect anomalies occurring in nuclear power plants at the early stage and to prevent the outbreak of a catastrophic accident. A method is presented to detect the anomaly in a reactor and the malfunction of detectors, such as of reactor pressure, steam flow, coolant flow and others. The method was tested by the plant dynamics simulator of the Japan Power Demonstration Reactor (JPDR). (auth)

14655 ON-SITE NOISE DIAGNOSTICS AT PALISADES NUCLEAR POWER STATION. Fry, D. N.; Kryter, R. C.; Robinson, J. C. (Oak Ridge National Lab., TN). pp 27.1-27.14 of Power Plant Dynamics, Control, and Testing. Knoxville, TN; Univ. of Tennessee (1973).

From an applications symposium on power plant dynamics, control and testing; Knoxville, Tennessee, USA (8 Oct 1973). See CONF-731021-.

A real-time noise analyzer was used on-site at the Palisades nuclear plant to diagnose the cause of neutron flux oscillations. This analysis was compared with an earlier off-site analysis of tape recorded signals that had been acquired and analyzed by the plant designer, Combustion Engineering, Inc. (CE). The ORNL measurements and conclusions are presented as an illustration of the use of on-site noise measurements in nuclear power plants. Recommendations for application of noise analysis in nuclear plants are included. 5 references. (auth)

14656 EFFECT OF REGULATION POSSIBILITIES OF A NUCLEAR HEAT SOURCE ON THE OPERATION OF A HEAT-AND-POWER PLANT SYSTEM. Bortlik, J. Bull. EGU; No. 77, 19-22(1972). (In Czech).

The operation of a nuclear heat source in a system of centralized

heat supply is affected by the mutual coupling between the dynamic properties of the generating block (reactor) and the regulation demands of heat consumption, here notably in daily cross section. An evaluation is presented of the problems using the generalized type diagrams of heat requirement variations. 6 references. (auth)

14657 FREQUENCY RESPONSE TESTING IN NUCLEAR REACTORS. Kerlin, T. W. Nuclear Science and Technology. Volume 11. New York; Academic Press, Inc. (1974). 185p. $19.00.

The analysis of the frequency response of power reactors is described using nonsinusoidal input perturbations. Information is presented concerning the mathematical background, properties of important test signals, data analysis, nuclear reactor frequency response, interpretation of results, equipment for introducing test perturbations, and testing experiences. (DCC)

Nuclear Power Plant Economics

Refer also to abstracts 14534 and 14676.

14658 (AEEW-M-1261) DESALINATION OF SEAWATER BY THE USE OF NUCLEAR ENERGY. Wood, F. C. (UKAEA Reactor Group, Winfrith. Atomic Energy Establishment). Apr 1974. 16p. (CONF-740538-1). Dep. NTIS (US Sales Only) $4.00.

From 3rd national conference on heat and nuclear energy problems of the Bulgarian Peoples Republic; Varna, Bulgaria (28 May 1974).

The results of some of the assessment studies done by the United Kingdom Atomic Energy Authority on the possible use of two U. K. reactor systems (the Advanced Gas Cooled Reactor and the Steam Generating Heavy Water Reactor) in dual-purpose desalination plants are presented. (auth)

14659 (CM/PBr-9506-73) EFFECT OF HEAVY-WATER REACTORS AND LIQUID FUEL REACTORS ON THE LONG-TERM DEVELOPMENT OF NUCLEAR ENERGY. Brand, P.; Wiechers, W. K. (Keuring van Electrotechnische Materialen N. V., Arnhem (Netherlands)). 1973. 11p. INIS.

The reactor strategies presented are only to indicate that next to the fast breeders other reactor types deserve appropriate attention. This indication has had a determining influence on the "Dutch effort" in the field of thermal breeder reactor development. Reactor strategy calculations, such as the ones presented, prove that the interactions in a nuclear power production system consisting of a number of reactor types are extremely complex. Even looking only at the uranium demand, which of course is the most basic criterium for evaluating nuclear strategies, the degrees of freedom are confusing and an optimal solution is difficult to obtain. Further studies of these strategies will clearly be needed to obtain a better understanding of the consequences of a large nuclear power production. (INIS)

14660 (CONF-730904-P1) PROCEEDINGS OF THE FOURTH INTERNATIONAL SYMPOSIUM ON FRESH WATER FROM THE SEA, HEIDELBERG, SEPTEMBER 9–14, 1973. Volume 1. Delyannis, A.; Delyannis, E. (eds.). (European Federation of Chemical Engineering. Working Party on Fresh Water from the Sea). 1973. 478p. (In several languages).

A total of forty seven papers presented on the topics of heat and mass transfer and distillation processes is included. (DG)

14661 (CONF-730904-P2) PROCEEDINGS OF THE FOURTH INTERNATIONAL SYMPOSIUM ON FRESH WATER FROM THE SEA, HEIDELBERG, SEPTEMBER 9–14, 1973. Volume 2. Delyannis, A.; Delyannis, E. (eds.). (European Federation of Chemical Engineering. Working Party on Fresh Water from the Sea). 1973. 496p. (In several languages).

A total of forty five papers presented on the topics of scale formation and prevention, corrosion, water supply and desalting, nuclear desalination, geothermal desalination, agro-industrial complexes, and chemicals from seawater is included. A separate abstract was prepared for each of three papers. One paper was previously abstracted for NSA (28: 17614). (DG)

For abstracts of individual papers see: 14662–14664.

14662 (CONF-730904-P2, pp 439-446) DIABLO CANYON DESALTING PROJECT. Brice, D. B. (California Dept. of Water Resources, Sacramento); Shiozawa, S. 1973.

From 4th international symposium on fresh water from the sea; Heidelberg, F. R. Germany (9 Sep 1973).

A study conducted to evaluate the technical and economic feasibility of a proposed large-scale prototype sea water desalting plant is described. The project was planned to be located adjacent to nuclear power units now under construction at the site located along the central coast of California, USA. Steam would be obtained from the nuclear reactors. The 40 million gallons per day desalter was estimated to cost about $66 million and the cost of desalting the sea water was estimated to be $0.73 per 1,000 gallons at the plant site. (auth)

14663 (CONF-730904-P2, pp 465-477) RATIONAL UTILIZATION OF DESALTED WATER IN AN AGRO-INDUSTRIAL COMPLEX. Domestic and Industrial Use First and then Irrigation. Balligand, P.; Alexandre, D.; Fourcy, A. (CEA, Paris). 1973. (In French).

From 4th international symposium on fresh water from the sea; Heidelberg, F. R. Germany (9 Sep 1973).

Desalted water is rather costly, in spite of the efforts to reduce its price. In the Agro-Industrial Complex concept, industry and agriculture are associated for a better use of the nuclear power station: energy and distilled water. A type of complex is proposed where the industrial component is relatively large compared to the agricultural component. The first use of desalted water would be urban and industrial. Sewage would be treated and applied in a second step to irrigation. Different processes are described and discussed with reference to conventional sewage treatment facilities already operational. Some drawbacks in the utilization of water reclaimed from used water, such as the total dissolved matter, become advantages for irrigation. (auth)

14664 (CONF-730904-P2, pp 479-489) TEXAS NUPLEX. The Texas A and M University Nuplex Study. Davison, R. R. (Texas A and M Univ., College Station). 1973.

From 4th international symposium on fresh water from the sea; Heidelberg, F. R. Germany (9 Sep 1973).

The Texas A&M Nuplex Study involved fundamental research in intensified agriculture, direct contact heat transfer in sea water desalting, and an economic evaluation of various Nuplex sites in Texas. The results favored industrial locations; and deepwater port studies indicated a reorientation of the complex toward transportation plus nuclear energy and petroleum processing. (auth)

14665 (CONF-730904-P3) PROCEEDINGS OF THE FOURTH INTERNATIONAL SYMPOSIUM ON FRESH WATER FROM THE SEA, HEIDELBERG, SEPTEMBER 9–14, 1973. Volume 3. Delyannis, A.; Delyannis, E. (eds.). (European Federation of Chemical Engineering. Working Party on Fresh Water from the Sea). 1973. 455p. (In several languages).

A total of forty two papers presented on the topics of ion exchange, desalination membranes, electrodialysis, other ionic processes, freezing processes, and hydrate processes is included. (DG)

14666 (CONF-730904-P4) PROCEEDINGS OF THE FOURTH INTERNATIONAL SYMPOSIUM ON FRESH WATER FROM THE SEA, HEIDELBERG, SEPTEMBER 9–14, 1973. Volume 4. Delyannis, A.; Delyannis, E. (eds.). (European Federation of Chemical Engineering. Working Party on Fresh Water from the Sea). 1973. 508p. (In several languages).

A total of fifty papers presented on the topics of reverse osmosis, piezodialysis, solar evaporation, and water structure is included. (DG)

14667 (KWU-163) ELECTRIC POWER TOMORROW. Future Power Plant Developments as Seen in 1971. (Kraftwerk Union A.G., Erlangen (F.R. Germany)). 1971. 20p. (In German). INIS.

Conventional power plants are still of importance despite the advances in nuclear energy. Nuclear fuel is particularly stable in price and its supply in secure. Thermal power plants are the least harmful of all primary energy consumers to the environment, however the viewpoints of environmental protection are becoming increasingly critical economically. Nuclear power plants keep the air clean and their safety technique is more highly developed than any other. Waters are not further polluted by power plants, rather less so; the heating problem is solved. In the future supply structure, each type of power plant has a clearly outlined task. (GE)

14668 FUTURE TRENDS IN NUCLEAR POWER GENERATION. Hill, S. J. (United Kingdom Atomic Energy Authority, London). Phil. Trans. Roy. Soc. London, Ser. A; 276: No. 1261, 587-601(30 May 1974).

From Energy in the 1980s; London, Eng. (15 Nov 1973).

In the 20 years since the Calder Hall reactors were ordered, the U.K. has accumulated wide experience of building and operating nuclear power stations. Early stations proved expensive because of technological novelty and infrequent orders, but the economics of nuclear power stations where regular orders can be assured are increasingly favorable. Other factors do not provide fundamental limitations to nuclear power growth. Trends in fossil-fuel prices suggest that most utilities will look mainly to nuclear plants to meet their electricity requirements. The substantial conservation of fossil fuels already achieved will thus

grow rapidly on a world-wide basis. Though it would take quite unexpected shifts in relative economics for nuclear stations completely to supplant conventional stations, particularly for peak demand situations, a high nuclear share of new capacity may begin to throw some strain on uranium reserves in the 1980s. The fast reactor, prototypes of which after long and careful development are being commissioned in France, Russia and the U. K., can provide a huge increase obtainable from uranium resources, pending the successful introduction in the long term of fusion reactors. (auth)

14669 NINTH NATIONAL CONGRESS OF THE SOCIETY OF ELECTRONIC, ELECTRICAL, AND RADIO ENGINEERS. Opening Conference: Technical Aspects. Chevrier, C. (Societe des Electriciens, Malakoff, France). Rev. Gen. Elec.; 82: No. 11, 673-678(Nov 1973). (In French).

From 9th congress of the Society of Electrical, Electronic and Radio-Engineers; Vittel, France (11 Sep 1973).

The importance of accelerating electronuclear developments in view of meeting growing energy demands and the predicted scarcity of fossil fuels in the future is discussed. The objectives of such developments are defined. The choice of reactor is then discussed together with uranium enrichment problems and environmental problems (safety of installations, storage of wastes). Electronic and electrotechnical problems associated with nuclear installations are reviewed. The relation of the electronuclear program with the development of different means for producing and transporting electrical energy is considered. (FR)

14670 ROLE OF FAST REACTORS IN THE STRUCTURE OF THE DEVELOPING NUCLEAR POWER SYSTEM. Bobolovich, V. N.; Koryakin, Yu. I.; Levental, G. B.; Chernavskii, S. Ya.; Baskakova, N. A.; Chernysheva, T. P. At. Energ. (USSR); 36: No. 4, 251-257(Apr 1974). (In Russian).

Certain aspects of fast reactor introduction in the developing nuclear power system are discussed. The investigation is conducted by means of mathematical modeling methods for determining its optimal structure from an economic viewpoint. There are considered hypotheses of nuclear power growth rates, various strategies with respect to reactor types and schedules for mass introduction of fast reactors etc. It is shown that such reactors should occupy a significant place in an optimal nuclear power structure before the year 2000 from the standpoint of effectively improving the economic competitiveness of nuclear power and solving its fuel problem. (auth)

14671 OPERATIONAL EXPERIENCE IN NUCLEAR POWER STATIONS. Broom, T.; Gow, R. S. (Central Electricity Generating Board, London). Phil. Trans. Roy. Soc. London, Ser. A; 276: No. 1261, 571-586(30 May 1974).

From Energy in the 1980s; London, Eng. (15 Nov 1973).

From the first self-sustaining nuclear reaction to the present day represents a span of three decades: within that time large-scale generation of electrical power from nuclear energy has become acknowledged as economic, safe and environmentally acceptable. Within the U. K. 10% of electricity consumed is of nuclear origin. Some of the C.E.G.B. reactors have been in service for over 10 years. The operating experience that has been gained shows how the original design concepts have been ultimately developed. Some of the difficulties encountered and the engineering solutions are presented. Operating experience feeds back to the design philosophy and safety requirements for future nuclear plants. In this way a foundation is provided for the further exploitation of what must become a major source of energy in the next decade. (auth)

14672 NUCLEAR ENERGY IN THE CENTER OF INTEREST OF ENERGY POLITICS. Mandel, H. (Rheinisch-Westfaelisches Elektrizitaetswerk AG, Essen). Atomwirt., Atomtech.; 19: No. 1, 18-22(Jan 1974). (In German).

The long-term problems of energy supply in the Federal Republic of Germany and the duties nuclear energy has to fulfill in this field are discussed. Independent of the actual crisis, it will be necessary to reduce the dependency on foreign mineral oil by its substitution by other energy sources and by intensifying the yield of mineral oil and natural gas in the Federal Republic itself. The expected price increase for mineral oil and natural gas will lead--also for economical reasons--to an even higher increase of the share of nuclear energy in the future generation of electricity. But considerable efforts will already have to be made to fulfill the Governmental Energy Programme, set up before the crisis, providing for nuclear power plants of 18,000 MW up to 1980, and 40,000-50,000 MW up to 1985. Above all, the process of site selection and the licensing procedures for nuclear power plants must be improved and accelerated by standardization and rationalization. Safety standards should be worked within the framework of an international cooperation. (GE)

14673 ECONOMIC BENEFITS OF NUCLEAR POWER PLANTS. Marcus, M. Pub. Util. Fortn.; 93: No. 13, 26-30(20 Jun 1974).

A framework for measuring the economic benefits of nuclear power must include balancing economic needs against environmental costs. Primary benefits are those inherent in the value of the generated electricity which is delivered to the consumers. Additional benefits include tax revenues, temporary and new jobs, recreational values, improved wildlife habitats, and improvement of transportation facilities. The AEC places emphasis on the relationship of expected revenues to cost, which is a questionable approach when dealing with a regulated public utility whose revenues are set at a level intended to equal costs. In addition the AEC approach involves double accounting of some benefits so it would appear that the AEC guidelines need to be reexamined. (FS)

14674 TRENDS IN NUCLEAR POWER PLANT DEVELOPMENT. Bedenig, D. (General Atomic Europe, Zurich). Kerntechnik; 16: No. 3, 101-107(Mar 1974). (In German and English).

In the future, nuclear energy will not only cover a steadily increasing proportion of the demand for electric power, but will also be used increasingly for the production of synthetic hydrocarbons and later for the production of hydrogen by thermochemical decomposition of water. The only reactor system capable of meeting all the essential requirements of the future energy market is the high-temperature reactor. The optimal long-term solution could consist of a symbiosis of fast breeder reactors, especially gas-cooled fast breeder reactors, and high-temperature reactors. The main function of the breeder reactors would be to produce uranium 233 which is the optimal fuel for thermal reactors. (GE)

14675 NUCLEAR POWER STATIONS IN EUROPE: YESTERDAY, TODAY, AND TOMORROW. Koenig, H. H. (Brown, Boveri und Cie A. G., Mannheim, Ger.). At. Strom; 20: No. 3/4, 18-29 (Mar 1974). (In German).

From 5th FORATOM congress; Florence, Italy (15 Oct 1973).

A summary of the papers presented at the 5th FORATOM conference (Oct., 1973) is given. Experience gained over a 10-year period in the planning, construction, and operation of nuclear power plants with PWR, BWR, and GCR type reactors is discussed. Some topics covered in greater detail are reactor commissioning, lack of internationally recognized safety criteria, necessity of standardized installations, reasons for longer construction times, importance of quality control, site selection, environmental impact, and rising capital costs. The development of high temperature reactors for electric power and process heat generation was mentioned together with the introduction of LMFBRs. Projected nuclear energy growth to 1990 in the FORATOM countries is shown in tables. (GE)

Reactor Fuel Cycle Economics

14676 (WASH-1139-74) NUCLEAR POWER GROWTH, 1974-2000, (USAEC Office of Planning and Analysis, Washington, D. C.). Feb 1974. 78p. Dep. NTIS $7.00.

A forecast of the growth of nuclear power in the United States and the rest of the world represents a current evaluation of domestic and foreign trends in the growth of nuclear power, the future capability of foreign nations to supply uranium enrichment services to reactor operators, the timing and application of plutonium recycle technology, and the timing and rate of introduction of the fast-breeder reactor. A total of seven separate cases has been prepared, four for the United States and three for the rest of the world. These cases are not intended to specify precise future situations but rather to provide a reasonable range of estimates of the growth of nuclear power and the concomitant range of requirements for separative work, uranium and related materials and services. Forecasts for the next decade are based on an analysis and evaluation of nuclear plants already operating, those under construction, and those planned. Forecasts beyond this period and to the year 2000 are based on extrapolations of near-term growth trends together with differing assumptions about future trends in energy consumption and electricity generating capacity. (auth)

14677 ISOTOPIC PLUTONIUM MANAGEMENT FOR A MIXED FAST/THERMAL REACTOR SYSTEM. Goodrich, J. M. Stanford, CA; Stanford University (1973). 222p. University Microfilms Order No. 74-6482.

Thesis (Ph. D.).

The incentives are analyzed for operating a combined thermal and fast reactor fuel cycle and managing the isotopes of plutonium in a way to optimize the system. The importance of isotopic plutonium upon fuel management strategies is presented. This is accomplished by applying basic systems analysis techniques to develop a simplified system model. Using this model, plutonium management strategies which consider isotopic dif-

ferences in reactor-produced plutonium are found to reduce the overall system fuel cycle cost. The separation of uranium-238 from plutonium in fabricated fuel is shown to increase the flexibility of plutonium management. (Diss. Abstr. Int., B)

14678 NUCLEAR FUEL CYCLE: WHAT'S HAPPENING TODAY. Schwieger, R. G. Power; 117: No. 9, 29-36; 112-115(Sep 1973).

The growth of nuclear power production is briefly discussed. Licensing delays, soaring plant costs, and fuel failures have led to a different philosophy on fuel management and more interest is placed on enrichment with price advances for services and the proposed changes in contractual arrangements with the government-owned diffusion plants. Utilities and fuel manufacturers are investigating plutonium recycle and the subsequent savings in fuel-cycle cost that it offers. Gas-centrifuge is compared with gaseous diffusion for producing enriched uranium. A pooling or brokerage service is necessary for separative work units due to AEC's new fixed-commitment contracts. Licensing, fuel design, fuel manufacturing, and the uranium market are discussed. (MCW)

Reactor Licensing and Regulation

14679 (FIND-50338) FIND: NORTH ANNA POWER STATION, UNITS 1 AND 2. Horn, F. H. (ed.). (USAEC Technical Information Center, Oak Ridge, Tenn.). Jul 1974. 29p. Dep. NTIS $4.00.

An index is presented for the docket report material submitted in conjunction with the application for a nuclear power plant construction permit and operating license. The index citations are to the beginnings of major headings, sections, responses, etc., and refer to grid coordinates on microfiche sheets prepared for each docket report. (DG)

14680 (FIND-50344) FIND: TROJAN NUCLEAR PLANT, UNIT 1. Items 1-100. Williams, W. H. (ed.). (USAEC Technical Information Center, Oak Ridge, Tenn.). Jun 1974. 23p. Dep. NTIS $4.00.

An index is presented for the docket report material submitted in conjunction with the application for a nuclear power plant construction permit and operating license. The index citations are to the beginnings of major headings, sections, responses, etc., and refer to grid coordinates on microfiche sheets prepared for each docket report. (DG)

14681 (NP-20031) STANDARD NUCLEAR QUALITY ASSURANCE PROGRAM MANUAL. (Stone and Webster Engineering Corp., Boston, Mass. (USA)). 22 Jan 1974. 105p.

Quality assurance requirements and tasks of Stone & Webster Engineering Corporation (S&W) in the design, procurement, construction, and testing of nuclear power stations are described. The requirements comply with the provisions of Appendix B, Part 50, Title 10 of the Code of Federal Regulations. Implementation requirements for specific S&W organizations are prescribed through drawings, specifications, instructions, and procedures. (auth)

14682 (RAI-74-5) REGULATORY ADJUDICATION ISSUANCES AND ISSUANCES OF THE BOARD OF CONTRACT APPEALS, May 1974. (USAEC Technical Information Center, Oak Ridge, Tenn.). Jun 1974. 136p. TIC $2.80.

Issuances received from the U. S. Atomic Energy Commission, the Atomic Safety and Licensing Appeal Boards, and the Atomic Safety and Licensing Boards are presented. (DG)

14683 (REG/G-1.3(Rev. 2)(6-74)) ASSUMPTIONS USED FOR EVALUATING THE POTENTIAL RADIOLOGICAL CONSEQUENCES OF A LOSS OF COOLANT ACCIDENT FOR BOILING WATER REACTORS. (USAEC Directorate of Regulatory Standards, Washington, D. C.). Jun 1974. 12p. DRS Free.

Section 50.34 of 10 CFR Part 50 requires that each applicant for a construction permit or operating license provide an analysis and evaluation of the design and performance of structures, systems, and components of the facility with the objective of assessing the risk to public health and safety resulting from operation of the facility. The design basis loss of coolant accident (LOCA) is one of the postulated accidents used to evaluate the adequacy of these structures, systems, and components with respect to the public health and safety. This guide gives acceptable assumptions that may be used in evaluating the radiological consequences of this accident for a boiling water reactor. In some cases, unusual site characteristics, plant design features, or other factors may require different assumptions which will be considered on an individual case basis. The Advisory Committee on Reactor Safeguards has been consulted concerning this guide and has concurred in the regulatory position. (auth)

14684 (REG/G-1.4(Rev. 2)(6-74)) ASSUMPTIONS USED FOR EVALUATING THE POTENTIAL RADIOLOGICAL CONSEQUENCES OF A LOSS OF COOLANT ACCIDENT FOR PRESSURIZED WATER REACTORS. (USAEC Directorate of Regulatory Standards, Washington, D. C.). Jun 1974. 6p. DRS Free.

Section 50.34 of 10 CFR Part 50 requires that each applicant for a construction permit or operating license provide an analysis and evaluation of the design and performance of structures, systems, and components of the facility with the objective of assessing the risk to public health and safety resulting from operation of the facility. The design basis loss of coolant accident (LOCA) is one of the postulated accidents used to evaluate the adequacy of these structures, systems, and components with respect to the public health and safety. This guide gives acceptable assumptions that may be used in evaluating the radiological consequences of this accident for a pressurized water reactor. In some cases, unusual site characteristics, plant design features, or other factors may require different assumptions which will be considered on an individual case basis. The Advisory Committee on Reactor Safeguards has been consulted concerning this guide and has concurred in the regulatory position. (auth)

14685 (REG/G-1.86(6-74)) TERMINATION OF OPERATING LICENSES FOR NUCLEAR REACTORS. (USAEC Directorate of Regulatory Standards, Washington, D. C.). Jun 1974. 5p. DRS Free.

Section 50.51, "Duration of license, renewal," of 10 CFR Part 50, "Licensing of Production and Utilization Facilities," requires that each license to operate a production and utilization facility be issued for a specified duration. Upon expiration of the specified period, the license may be either renewed or terminated by the Commission. Section 50.82, "Applications for termination of licenses," specifies the requirements that must be satisfied to terminate an operating license, including the requirement that the dismantlement of the facility and disposal of the component parts not be inimical to the common defense and security or to the health and safety of the public. This guide describes methods and procedures considered acceptable by the Regulatory staff for the termination of operating licenses for nuclear reactors. The Advisory Committee on Reactor Safeguards has been consulted concerning this guide and has concurred in the regulatory position. (auth)

14686 (RDT-STATUS-6-74) BIMONTHLY STATUS REPORT: RDT STANDARDS. Summary as of May 31, 1974. (USAEC Division of Reactor Research and Development, Washington, D. C.). 14 Jun 1974. 50p. RSO.

14687 (STI/DOC-10-153) ORGANIZATION OF REGULATORY ACTIVITIES FOR NUCLEAR REACTORS. A Manual Prepared By a Panel on Assessment of Reactor Safety Analysis, Vienna, 4-8 December 1972. (International Atomic Energy Agency, Vienna (Austria)). Apr 1974. 65p. IAEA $3.00.

Guidance is presented for Member States embarking on a nuclear power program for: (a) establishing the regulatory body to which is assigned the responsibility for licensing stationary nuclear power plants; and (b) organizing for and conducting the assessment of nuclear safety of these plants, and for conducting the necessary inspections to ascertain that the conditions of the licenses are being fulfilled by the designers, constructors and operators. (auth)

14688 AEC BEARS DOWN ON NUCLEAR QUALITY ASSURANCE. Olds, F. C. Power Eng.; 78: No. 6, 41-47(Jun 1974).

The development of quality assurance requirements by the AEC for the construction and operation of nuclear power plants is reviewed. The effectiveness of the present quality assurance program is analyzed. (DCC)

14689 INDUSTRIAL SECURITY FOR NUCLEAR POWER PLANTS. New York; American National Standards Institute, Inc. (1973). 10p. (ANSI-N-18.17-1973). $10.00.

This standard provides criteria for industrial security programs to protect operational nuclear power plants from acts of industrial sabotage that could lead to a threat to the health and safety of the public. Owner organizations may have other strong incentives for protection of nuclear power plants, such as protection of employees and the large capital investment involved, or the preservation of reliable power sources. Although these other incentives are recognized to have significant impact in the preparation of security programs, and may derive collateral support from the provisions of this standard, they were not considered explicitly in the preparation of the standard. (auth)

14690 NUCLEAR SAFETY CRITERIA FOR THE DESIGN OF STATIONARY GAS COOLED REACTOR PLANTS. Hinsdale,

IL; American Nuclear Society (1974). 103p. (ANSI-N-213-1974). $15.00.

The GCR Criteria are intended for use in the design of the nuclear safety aspects of stationary GCR plants. Their objective is to provide assurance that GCR plants will be designed and constructed in such a manner that they may be operated without undue risk to the health and safety of the public. (auth)

14691 NUCLEAR SAFETY CRITERIA FOR THE DESIGN OF STATIONARY BOILING WATER REACTOR PLANTS. Hinsdale, IL; American Nuclear Society (1974). 123p. (ANSI-N-212-1974). $22.50.

It is the purpose of this standard to establish functional design requirements of safety related structures, systems and components to provide a degree of assurance that boiling water reactor plants will be designed and constructed so that they can be operated without undue risk to the health and safety of the public. It is intended that this objective be accomplished in this standard by defining existing practices which are consistent with the licensing requirements of the AEC and with appropriate industry codes. (auth)

14692 OPERATION FISHBOWL. Stroube, H. Pub. Util. Fortn.; 93: No. 13, 31-33(20 Jun 1974).

The Office of Public Responsibility (OPR) was established by the Potomac Electric Power Company (PEPCO) to develop nuclear power openly. All details and technical data on Douglas Point are available and qualified OPR staff members are available for guidance and explanation. PEPCO believes this will obtain public support, demonstrate confidence in engineering design affecting safety and the environment, facilitate communication, and identify public opposition with the end result of holding hearings on schedule, issuance of construction permits on schedule, and starting construction on schedule. (FS)

GENERAL

Energy Utilization and Economics

14693 (BNL-18651) IRON TITANIUM HYDRIDE AS A SOURCE OF HYDROGEN FUEL FOR STATIONARY AND AUTOMOTIVE APPLICATIONS. Reilly, J. J.; Hoffman, K. C.; Strickland, G.; Wiswall, R. H. (Brookhaven National Lab., Upton, N. Y. (USA)). 1974. 31p. (CONF-740407-4). Dep. NTIS $4.75.

From 26th power sources symposium; Atlantic City, New Jersey, USA (29 Apr 1974).

Hydrogen is a potential fuel for various types of power sources, such as fuel cells, internal combustion engines, gas turbines, etc. It has two great advantages over fossil fuels, it is essentially nonpolluting and it can be produced using inexhaustible energy sources, i.e. solar, nuclear and geothermal. However, a major problem is the difficulty encountered in its storage and bulk transport. Conventional storage methods, i.e. compression and liquefaction, do not appear to be practical in this context. A possible solution to the problem lies in the use of a metal hydride as a hydrogen storage medium. The material most near to practical application is iron titanium hydride ($FeTiH_{1.95}$). This material can be synthesized through the direct union of hydrogen with the intermetallic compound, FeTi, in a two-step reaction. $1.08\ FeTiH_{0.1} + H_2 \xrightarrow{25°C} 1.08\ FeTiH_{1.95}\ \Delta H \cong -7.5$ Kcal. A stationary hydrogen storage reservoir has recently been built and is currently undergoing performance tests. It contains 879 lb. of FeTi and will Store ~14 lb of hydrogen. The reservoir will be used in an experimental peak shaving unit being built by Public Service Electric & Gas Co. of New Jersey to examine the feasibility of storing electrical energy through the production, storage and reconversion of hydrogen. Iron titanium hydride is also of interest as a source of hydrogen fuel for automotive use. The energy density of $FeTiH_{1.95}$, on the basis of available hydrogen, is 268 whr/lb; a value that compares favorably with even the most advanced battery systems suggested for automotive use. However, in order to reap substantial benefits regarding fuel economy and environmental effects, hydrogen need not be used exclusively and the options available regarding multifuel (hydrogen-gasoline) vehicles will be discussed. (auth)

14694 (BNL-18887) METAL HYDRIDES AS HYDROGEN STORAGE MEDIA. A Summary with Appendix. Reilly, J. J.; Wiswall, R. H.; Hoffman, K. C.; Waide, C. H. (Brookhaven National Lab., Upton, N. Y. (USA)). May 1974. 23p. (CONF-740543-1). Dep. NTIS $4.25.

From 7th alternative automotive power systems division contractors coordination meeting; Ann Arbor, Michigan, USA (15 May 1974).

A summary of BNL's work on metal hydrides as hydrogen storage media is given. An appendix contains information on hydride heats of formation, energy density of automotive power sources, criteria for evaluation of a candidate metal hydride, and metal hydride screening experiments. (LK)

14695 (CEA-CONF-2562) STORAGE AND UTILIZATION OF LIQUID HYDROGEN ON BOARD THE "PEGASE". Bertrand, G.; Perroud, P.; Rebiere, J. (CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France)). Oct 1973. 20p. (In French). (CONF-731138-2). Dep. NTIS (US Sales Only) $4.00.

From AERALL colloquium; Paris, France (12 Nov 1973).

Results of a study of a cryogenic tank on board the "Pegase" platform are presented. A volume of 860 m^3 of liquid hydrogen necessary for the duration of a year's mission, is contained in one or three spherical reservoirs. The thermal insulation is obtained by superinsulators in a vacuum container, and the daily losses are 0.7%. The internal sphere, a light alloy (AZ56) or containing titanium, has a minimum weight of ~5 tons. The use of honey-combed material allows significant weight gain for the external sphere. The total weight of the reservoir is about 15 tons (structure index 0.25). Interest in the recondensation of hydrogen vapors and the utilization of mixed liquids-solids ("slush") is evaluated. The vaporization and reheating of hydrogen are done in a freon exchanger permitting the energy recovery necessary for cooling the compressed air for the combustion cells. (tr-auth)

14696 (ORNL-TM-4564) CALCULATING THE DAILY VARIATIONS OF SOLAR ENERGY INCIDENT ON FLAT PLATES. Derby, R. W. (Oak Ridge National Lab., Tenn. (USA)). May 1974. Contract W-7405-eng-26. 29p. Dep. NTIS $4.50.

A procedure for calculating the solar energy incident on flat plates of different orientations is given in detail. The use of latitude, declination, and time to find the azimuth and zenith angle of the Sun is explained. A convenient and quantitative description of how the attenuation of the Sun's rays varies with zenith angle is described. The results of sample calculations for latitude 32°N at the time of the solstices and equinoxes are presented. Finally, reference data and a listing of a short computer program are included. (auth)

Information Handling

14697 (AECL-4769) TECHNOLOGY TRANSFER. Perryman, E. C. W. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). Apr 1974. 16p. (CONF-740336-1). Dep. NTIS (US Sales Only) $4.00. AECL $0.50.

Technological transfer has been an important factor in the development of the CANDU (Canada Deuterium Uranium) reactor system and in the birth and growth of the Canadian nuclear industry. The difficulties involved with technology transfer, whether it be from a Canadian laboratory to Canadian industry, from Canada to another country, or from another country to Canada, are discussed in the light of experience gained during the development of the CANDU reactor system. (auth)

14698 (KFK-1825) SCIENTIFIC PUBLICATIONS OF THE NUCLEAR RESEARCH CENTER, KARLSRUHE, PUBLISHED IN 1972. (Kernforschungszentrum Karlsruhe (F. R. Germany)). 1973. 62p. (In German). INIS.

This KFK report lists the titles that appeared in the 1972 publications. Publications handed in to be printed are merely internally registered and only after they have been published are included in the publication list. An exception is made for lectures, these are valid from the date of the lecture as published and are listed if an available written copy has been given to the central library. In the case of patents, only first granting, patent applications open for public inspection (unexamined or examined by the patent office) are given. Summarizing specialist lectures and practical work instructions from courses in the School of Nuclear Technology are not on the list. This publication list ordered according to institute is mechanically produced, it is alphabetically ordered according to author referring to page and registration number. In addition to the Gesellschaft fuer Kernforschung publications, those of the Institute for Radiotechnology of the Federal Research Institute for Food Preservation within the Nuclear Research Centre are listed. In the final section of the list, publications on experiments by guest scientists on irradiation equipment are given. (GE)

Law

14699 GENERAL DESCRIPTION OF BELGIAN LAW RELATING TO RADIOLOGICAL PROTECTION. Halter, S. (Ministere de la Sante Publique et de la Famille, Brussels). Radiol. Prot. Bull.; No. 7, 4-8, 14(Apr 1974).

Brief note is made of the legal aspects of radiological protection in Belgium. The subject is dealt with under the following headings: legal basis of regulations, scope of application, supervision of classified establishments, basic rules governing maximum permissible doses, exposure and contamination, physical and medical supervision, education of workers, import, transit and distribution arrangements, preparation and marketing of radioisotopes used in unsealed form in human and veterinary medicine, possession and use of sources of ionizing radiation for medical purposes. (UK)

Mathematics and Computers

14700 (ANCR-1153) REBAL COMPUTER PROGRAM SERIES FOR LINEAR PROPAGATION OF UNCERTAINTY. Fussell, J. B.; Marshall, N. H. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA)). May 1974. Contract AT(10-1)-1375. 25p. Dep. NTIS $4.00.

14701 (BNWL-SA-4990) INTERACTIVE COMPUTER GRAPHICS SYSTEM APPLIED TO THE LIFE SCIENCES. Watson, C. R. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 14 Dec 1973. Contract AT(45-1)-1830. 164p. Dep. NTIS $11.25.

Thesis. Submitted to Orgeon State Univ., Corvallis.

Graph production by computer requires a blending of human effort in scale selection with computer precision in datum point placement. The development and application of a graph preparation system designed for unsophisticated users is described which is moderate in cost, easy to use, and provides immediate interactive response. It is written in BASIC on Univac 1108 and utilizes low cost Tektronix graphics terminals. Through menu selection, the user defines scale factors, datum point indicators, axis type

(linear or logarithmic), and adds optional functions which may be displayed superimposed on the data. Immediate display of the results to encourage user creativity in modification of parameters is an important feature of the system. Step-wise implementation, which maximized user input to system design, is described. Extensive modification of commercially obtained plot driving routines allows expansion of program features in accord with user requests. Four detailed examples illustrate the use of the system by biologists and ecologists in communucation of results and in analysis of data. A complete program listing and user's manual are appended. (auth)

14702 (COO-3498-16) SOLUTION OF THE PERCUS–YEVICK EQUATION IN TWO DIMENSIONS. Mandel, F. (Rochester Univ., N. Y. (USA). Dept. of Chemistry). 1974. Contract AT(11-1)-3498. 6p. Dep. NTIS $4.00.

14703 (IS-3396) DIRECT METHOD BASED ON PROJECTIONS FOR SOLVING SYSTEMS OF LINEAR EQUATIONS. Harms, D. W.; Keller, R. F. (Gulf Nuclear Fuels Co., Elmsford, N. Y. (USA)). May 1974. Contract AT(11-1)-2210. 70p. Dep. NTIS $5.45.

14704 (IUICDCS-R-74-641) SEMI-VIRTUAL MEMORY MULTI-PROGRAMMING SYSTEM FOR THE MINI-COMPUTER PDP 8/3 (ILLIAC-3). Wong, T. W. (Illinois Univ., Urbana (USA). Dept. of Computer Science). May 1974. 75p. Dep. NTIS $6.75.

14705 (KFK-1967) COORDINATION OF CRITICAL ACCESS TO DISTRIBUTED DATABANKS IN COMPUTER NETWORKS BASED ON DECENTRALIZED CONTROL. Holler, E. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Datenverarbeitung in der Technik). Apr 1974. 112p. (In German). Dep. NTIS (US Sales Only) $8.75.

14706 (LBL-2676) BARELY INTELLIGENT TERMINAL. Holmes, H. H. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Mar 1974. 22p. (CONF-740512-10). Dep. NTIS $4.25.

From 2nd AEC scientific computer information exchange meeting; New York, New York, USA (2 May 1974).

14707 (LBL-2679) COSTS AND BENEFITS OF USING MINI-COMPUTERS IN TELEPROCESSING. Fink, R. L. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 3 Apr 1974. Contract W-7405-eng-48. 7p. (CONF-740405-2). Dep. NTIS $4.00.

From AESOP-X conference; Albuquerque, New Mexico, USA (2 Apr 1974).

14708 (SAND-74-5018) CONVERSION OF BOUNDARY-VALUE PROBLEMS INTO STABLE INITIAL-VALUE PROBLEMS VIA SEVERAL INVARIANT IMBEDDING ALGORITHMS. Scott, M. R. (Sandia Labs., Albuquerque, N. Mex. (USA)). 1974. (CONF-740627-1). Dep. NTIS $6.50.

From conference on numerical solution of B. V. P. for O. D. E.; College Park, Maryland, USA (10 Jun 1974).

14709 (SLA-74-275) PRINCIPAL VALUES OF FORTRAN FUNCTIONS ON THE CDC 6600 AND DEC PDP-10. Bailey, C. B. (Sandia Labs., Albuquerque, N. Mex. (USA)). Jun 1974. Contract AT(29-1)-789. 7p. Dep. NTIS $4.00.

14710 (UCLA-10-P-14-126) MULTILEVEL MODEL FOR THE SYNTHESIS OF RELIABLE PROGRAMS. Lucena, C.; Estrin, G. (California Univ., Los Angeles (USA). Dept. of Computer Science). 1974. Contract AT(04-3)-34. 17p. (CONF-740649-1). Dep. NTIS $4.00.

From proceedings of SIGPLAN-IEEE-CS workshop on fault tolerant computing; Toronto, Canada (17 Jun 1974).

14711 (UCLA-10-P-14-128) EXPERIMENT WITH METHODOLOGIES FOR THE SPECIFICATION OF PROGRAMMING SYSTEMS. Lucena, C. J.; Tompkins, G. E. (California Univ., Los Angeles (USA)). 1973. Contract AT(04-3)-34. 6p. (CONF-731147-1). Dep. NTIS $4.00.

From seventh asilomar conference on circuits, systems, and computers; Pacific Grove, California, USA (27 Nov 1973).

14712 (UCRL-51529) SECOND AND THIRD ORDER DIFFERENCE TECHNIQUES FOR TWO-DIMENSIONAL HYPERBOLIC SYSTEMS OF CONSERVATION LAWS, WITH AN APPLICATION TO TRANSONIC FLOW ABOUT AN AIRFOIL. Mirin, A. A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 22 Apr 1974. Contract W-7405-eng-48. 80p. Dep. NTIS $5.45.

14713 (UCRL-51582) INTRODUCTION TO RATS (RISOS/ARPA TERMINAL SYSTEM): AN OPERATING SYSTEM FOR THE DEC PDP-11/45. Landau, C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 Mar 1974. Contract W-7405-eng-48. 297p. Dep. NTIS $18.00.

14714 (UCRL-75658) SOFTWARE FOR NONLINEAR PARTIAL DIFFERENTIAL EQUATIONS. Sincovec, R. F.; Madsen, N. K. (California Univ., Livermore (USA). Lawrence Livermore Lab.). May 1974. 57p. (CONF-740511-6). Dep. NTIS $6.00.

From mathematical software II conference; Lafayette, Indiana, USA (29 May 1974).

14715 (UCRL-75541) MTAS/8. Allen, M. J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 23 May 1974. 50p. (CONF-740533-1). Dep. NTIS $5.50.

From spring DECUS symposium; Boston, Massachusetts, USA (29 May 1974).

14716 (UIUCDCS-F-74-879) (SEMI-) VIRTUAL MEMORY MULTI-PROGRAMMING SYSTEM FOR THE MINI-COMPUTER PDP 8/e (ILLIAC-3) PROGRAM LISTING. Wong, T. W. (Illinois Univ., Urbana (USA). Dept. of Computer Science). May 1974. Contract AT(11-1)-2118. 93p. Dep. NTIS $7.75.

Miscellaneous

14717 (COO-3521-3) TECHNICAL PROGRESS REPORT OF BIOLOGICAL RESEARCH ON THE VOLCANIC ISLAND SURTSEY AND ENVIRONMENT FOR THE YEAR 1973. Fridriksson, S. (Surtsey Research Society, Reykjavik (Iceland)). [nd]. Contract AT(11-1)-3521. 124p. Dep. NTIS $9.25.

Chemistry

14718 (ORO-3018-125) ASSIGNMENT OF MOLECULAR RYDBERG TRANSITIONS. II. Energy Separations of the 1s Rydberg Levels of Monohalides. Hochmann, P.; Templet, P. H.; McGlynn, S. P. (Louisiana State Univ., Baton Rouge (USA). Coates Chemical Labs.). 1973. 25p. Dep. NTIS $4.25.

14719 (ORO-3018-126) ASSIGNMENT OF MOLECULAR RYDBERG TRANSITIONS. III. Low-Energy Rydberg Transitions in Mercury Halides. Templet, P. H.; Hochmann, P.; McGlynn, S. P. (Louisiana State Univ., Baton Rouge (USA). Coates Chemical Labs.). 1972. 34p. Dep. NTIS $4.75.

14720 (ORO-3018-127) ELECTRONIC SPECTROSCOPY OF HIGHLY-POLAR AROMATICS. IX. Cyanoanisoles. Lui, Y. H.; McGlynn, S. P. (Louisiana State Univ., Baton Rouge (USA). Coates Chemical Labs.). 1973. 21p. Dep. NTIS $4.25.

14721 (UCRL-Trans-10707) FULL AUTOMATIC MULTIPLE TITRATION. Bauer, W. Translated From G–I–T (Glas-Instrum.-Tech.) Fachz. Lab.; 15: No. 11, 1249-1252(Nov 1971). 11p. Dep. NTIS $4.00.

The automatic multiple titration machine is well-suited for multiple titrations with an electrochemically detectable end point. Remarkable features are the adaptability of the machine to very different problems, the fully electronic construction of the automatic control, and the pneumatic motive power, which proved itself during continuous operation. The satisfactory results of the analysis, which are expressed in the extraordinarily favorable relative standard deviation, can be further processed by E. D. P. (auth)

Life Sciences

14722 (CEA-R-4560) ISOLATION AND CRYSTALLIZATION OF NUCLEOSIDE DIPHOSPHOKINASE FROM BEEF HEART. Duplaa, A. M. (CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France)). May 1974. 14p. (In French). Dep. NTIS (US Sales Only) $4.00.

14723 (COO-2155-10) BIOMEDICAL ENGINEERING SUPPORT. First Quarterly Report for 1973–1974. Kolff, W. J.; Smith, L. M.; Sandquist, G. M. (Utah Univ., Salt Lake City (USA). Inst. for Biomedical Engineering). [nd]. Contract AT(11-1)-2155. 27p. Dep. NTIS $4.50.

14724 (COO-2155-11) BIOMEDICAL ENGINEERING SUPPORT. Second Quarterly Report, November 16, 1973–February 15, 1974. Kolff, W. J.; Smith, L. M.; Sandquist, G. M. (Utah Univ., Salt Lake City (USA). Inst. for Biomedical Engineering). [nd]. Contract AT(11-1)-2155. 40p. Dep. NTIS $5.00.

14725 (COO-3139-11) PROTEINS IN GROWTH REGULATION DURING EARLY DEVELOPMENT OF THE CHICK EMBRYO. Klein, N. W. (Connecticut Univ., Storrs (USA). Dept. of Animal Genetics). 1974. Contract AT(11-1)-3139. 89p. Dep. NTIS $7.50.

14726 (COO-3139-12) PROTEINS IN GROWTH REGULATION DURING EARLY DEVELOPMENT OF THE CHICK EMBRYO. Progress Report, May 1973–May 1974. Klein, N. W. (Connecticut Univ., Storrs (USA). Dept. of Animal Genetics). 1974. Contract AT(11-1)-3139. 14p. Dep. NTIS $4.00.

14727 (COO-3278-21) GROWTH AND DISSIPATION OF PHYTOPLANKTON IN CHESAPEAKE BAY. III. Inorganic Carbon Requirements of Natural Populations and Laboratory Cultures of Phytoplankton. Loftus, M. E.; Place, A.; Seliger, H. H. (Johns Hopkins Univ., Baltimore, Md. (USA)). 1973. Contract AT(11)-3278. 34p. Dep. NTIS $4.75.

14728 (COO-3278-24) MEASUREMENTS OF ABSOLUTE SCALAR IRRADIANCE SPECTRA IN RHODE RIVER. Esaias, W. E.; Biggley, W. H.; Seliger, H. H. (Johns Hopkins Univ., Baltimore, Md. (USA)). 1972. 31p. Dep. NTIS $4.75.

14729 (COO-3565-3) MARINE MICROBIOLOGY. Progress Report, 1973–1974. Watson, S. W. (Woods Hole Oceanographic Institution, Mass. (USA)). 1974. Contract AT(11-1)-3565. 40p. Dep. NTIS $5.00.

These studies have dealt with the role bacteria play in the mineralization of plant nutrients in the ocean. A new method based on the Limulus lysate test for the detection of Gram-negative lipopolysaccharides was developed and utilized to determine the horizontal and vertical distribution of bacteria in the oceans. This test was used in conjunction with the ATP method to determine what percentage of the total biomass in oceanic environments was comprised of bacteria. The biochemical events occurring when the Limulus lysate was reacted with Gram-negative lipopolysaccharides were investigated. The role of the nitrogen-fixing bacteria in oceanic waters was examined. (auth)

14730 (ORO-4254-24) DIEL PERIODICITY IN UPTAKE OF NITRATE AND NITRITE BY RESERVOIR PLANKTON. Toetz, D. (Oklahoma State Univ., Stillwater (USA)). 1973. Contract AT(40-1)-4254. 12p. Dep. NTIS $4.00.

14731 (TID-26579) POLAR ASPECTS OF SPONTANEOUS RECOMBINATION IN F-MERODIPLOID DERIVATIVES OF ESCHERICHIA COLI K12. Bay Van Nguyen; Butler, M. A.; Matney, T. S. (Texas Univ., Houston (USA). Graduate School of Biomedical Sciences). May 1974. 13p. Dep. NTIS $4.00.

Materials

14732 (RFP-Trans-159) THEORY OF THE ABSOLUTE THERMOELECTRIC POWER OF THIN METAL FILMS AND WIRES. Justi, E.; Kohler, M.; Lautz, G. Translated from Z. Naturforsch.; 6a: 544-550(1951). 10p. Dep. NTIS $4.00.

Physics and Engineering

14733 (COO-2220-23) QUANTUM DYNAMICS OF A MASSLESS RELATIVISTIC STRING. II. Patrascioiu, A. (Institute for Advanced Study, Princeton, N. J. (USA)). May 1974. Contract AT(11-1)-2220. 37p. Dep. NTIS $5.00.

14734 (DEMO-74-1) LOWER BOUND FOR THE L^1 NORM OF EXPONENTIAL SUMS. Pichorides, S. K. (Democritus Nuclear Research Center, Athens (Greece)). 1974. 8p. Dep. NTIS (U. S. Sales Only) $4.00.

Let f(x) be a trigonometric polynomial with N (≥2) nonzero coefficients of absolute value not less than 1. It is proved that the L^1 norm of f exceeds a fixed positive multiple of $(\log N/\log\log N)^{\frac{1}{4}}$. This result improves a previous one due to H. Davenport and P. Cohen (the same bound with exponent $\frac{1}{4}$). (auth)

14735 (KFK-1671) CAMAC BIBLIOGRAPHY. Supplement. Tradowsky-Thal, I. (Kernforschungszentrum Karlsruhe (F. R. Germany). Labor fuer Elektronik und Messtechnik). Oct 1972. 56p. INIS.

14736 (KFK-1909) REGEN: A FORTRAN PROGRAM FOR THE THERMOHYDRAULIC DESIGN OF A REGENERATIVE COOLING TOWER. Neitzel, H. J.; Wiehr, K. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Reaktorbauelemente). Feb 1974. 29p. (In German). Dep. NTIS (US Sales Only) $4.50.

14737 (KFK-1938) MULTIPLE SCATTERING OF GAMMA RAYS ON FERROMAGNETIC PLATES. Bock, P. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Experimentelle Kernphysik). Apr 1974. 25p. (In German). Dep. NTIS (U. S. Sales Only) $4.25.

If nuclear gamma rays are scattered on a magnetized metal plate, the intensities of singly and doubly scattered photons depend on the magnetization, because the scattering cross sections for unpolarized and linearly polarized photons are functions of the electron polarization. A computer program is presented, which was designed to calculate these effects numerically. The program incorporates the Faraday rotation of the photon polarization plane, calculated previously. Hence, all polarization phenomena in single and double scattering processes are treated completely. (auth)

14738 (LA-5581-PR) USAEC-DAT DC SUPERCONDUCTING POWER TRANSMISSION LINE PROJECT AT LASL. Progress Report, October 1–December 31, 1973. Keller, W. E.; Taylor, R. D. (comps.). (Los Alamos Scientific Lab., N. Mex. (USA)). Apr 1974. Contract W-7405-eng-36. 18p. Dep. NTIS $4.00.

14739 (LBL-2712) HIGH RESOLUTION IMAGING IN BRIGHT AND DARK FIELD AT HIGH VOLTAGES. Chen, L. J.; Seshan, K. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Mar 1974. Contract W-7405-eng-48. 3p. (CONF-740803-3). Dep. NTIS $4.00.

From thirty-second annual meeting of the electron microscopy society and exhibition; St. Louis, Missouri, USA (13 Aug 1974).

14740 (UCRL-Trans-10737) DEEP SEISMIC SOUNDING. Papers Presented at the Second All-Union Conference on the Study of the Earth's Crust and Upper Mantle by Methods of Explosion Seismology, Alma-Ata, November 1969. Egorova, L. F. (ed.). (CONF-691141-). 1969. Translated by A. M. A. Mincer from Glubinnoe Seismicheskoe Zondirovanie. 443p. Dep. NTIS $25.25.

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